National Street Improvements Study: Minneapolis, MN Report

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.

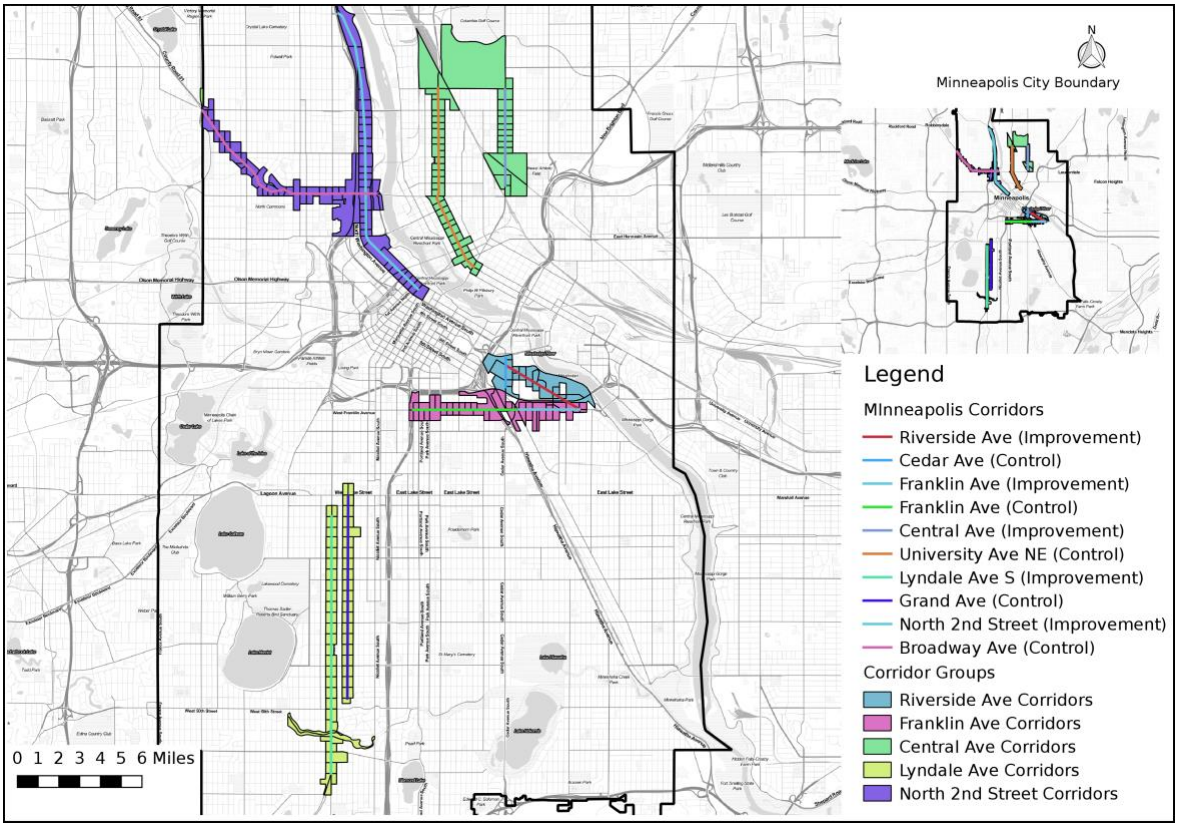

Figure 1-1. Minneapolis Corridors Map

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?

Minneapolis has conducted many street improvement projects in past years, including new bike lanes and road diets. This report explores five recent street improvement corridors—Riverside Avenue, Franklin Avenue, Central Avenue, Lyndale Avenue South and North Second Street—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 principal contact was with the Minneapolis Department of Public Works. Sales tax data was provided by the Minneapolis Community Planning and Economic Development (CPED) department; QCEW data was provided by the Minnesota Department of Employment and Economic Development; and LEHD data was publicly available at the United State Census Bureau.

First, we used the Longitudinal Origin-Destination Employment Statistics (LODES) data set from the **Longitudinal Employer-Household Dynamics Dataset** (LEHD). It integrates existing data from state-supplied administrative records on workers and employers with existing census, surveys, and other administrative records to create a longitudinal data system on U.S employment. This data set tracks Workplace Area Characteristics (WAC), census blocks where people work as opposed to where workers live, for all the census blocks between 2002 and 2015 for most of the states in the US. As such, LEHD provides geographically granular detail about American's jobs, workers and local economies, allowing us to examine employment by broad industry sector, wage and educational attainment. Some disadvantages of the LODES data set are that in order to guarantee confidentiality block level data is "fuzzed" so the numbers are not exactly the number of jobs, but they are accurate estimates. Additionally, though we get industrial data, it is only provided at the most general level (the equivalent of two digit NAICS codes) so we are unable to isolate specific retail or service employment such as restaurant workers. That being said, the LEHD data set is comprehensive, offers unprecedented geographic detail, and longitudinal allowing for consistent comparisons over time.

This report also takes advantage of establishment level **Quarterly Census of Employment and Wages** (QCEW) data. Also referred to as ES-202 data, the QCEW is quarterly data submitted by firms to their respective state governments as part of the unemployment insurance system. Employers report their industry code, their number of employees at the site, and gross pay. The individual establishment-level QCEW data is confidential and requires special permission from the state in order to use it and has additional data use restrictions. The QCEW gives us address level data on individual establishments as well as detailed employment information. Unfortunately, getting access to such data can be difficult and differs for each state and has to be presented in a way to preserve confidentiality. As such, we cannot present ultra-detailed industrial information and have further presentation restrictions depending on the state.

Due to data suppression for confidentiality by the state, we were unable to get dis-aggregated individual three-digit NAICS employment figures for the Minneapolis corridors. As a compromise, Minnesota's Department of Employment and Economic Development (DEED) aggregated all of the three-digit NAICS codes (NAICS 442-453), which only includes the retail sectors, but not food and accommodation services. These aggregated numbers

correspond closely to the LEHD codes used in the report, but with the advantage that the numbers are not "fuzzed" for confidentiality concerns, the data include total wages paid and average employment. This data is available quarterly and goes back to the year 2000, dramatically increasing our sample size.

Finally, we also collected **sales tax data**. Sales tax data allows us to estimate a more sensitive measure of economic activity than employment (as the decision to hire or fire for a firm is often an expensive one we expect employment to be a delayed response). Some drawbacks of sales tax data is 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. Specifically, for Minneapolis, we have collected **taxable sales** for all retail industrial categories and restaurants.

In terms of specific rates, Minneapolis sales tax is, at minimum, 8.025% (for example, buying a meal at a restaurant outside of downtown Minneapolis) up to 14.025% (for ordering a meal in a restaurant with live entertainment within the downtown taxing district). The minimal 8.025% rate includes the 6.875% state sales tax, a 0.5% transit tax for Hennepin County, an additional 0.15% Hennepin County tax and, finally, a 0.5% city sales/use tax. Additional entertainment and accommodations taxes may also be included. However, general clothing, legal drugs and unprepared food are exempted from tax collection, which may hamper the ability of sales tax data to accurately reflect all retail business vitality.

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 the treatment and control corridors, we accept the corridor pair as similar enough for this analysis; 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.

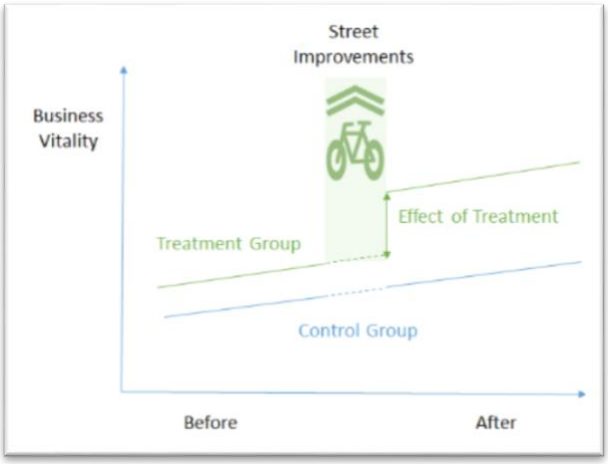

Figure 2-1. Illustration of DID method

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.

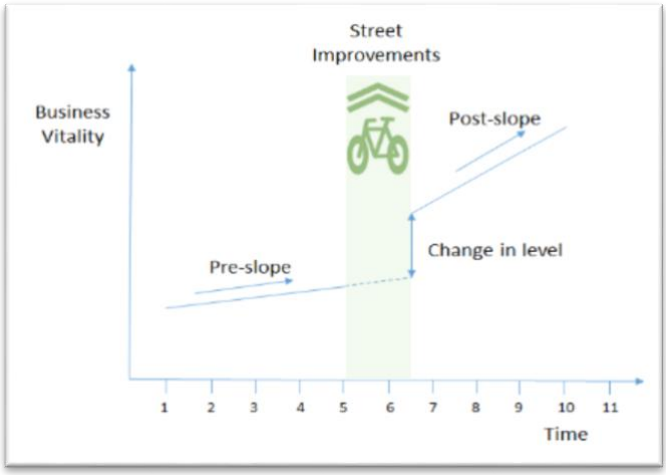

Figure 2-2. Illustration of ITS method

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 number of business jobs, retail, and food service industry jobs per block on the corridors to number of jobs per block for the city of Minneapolis 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 Riverside Avenue

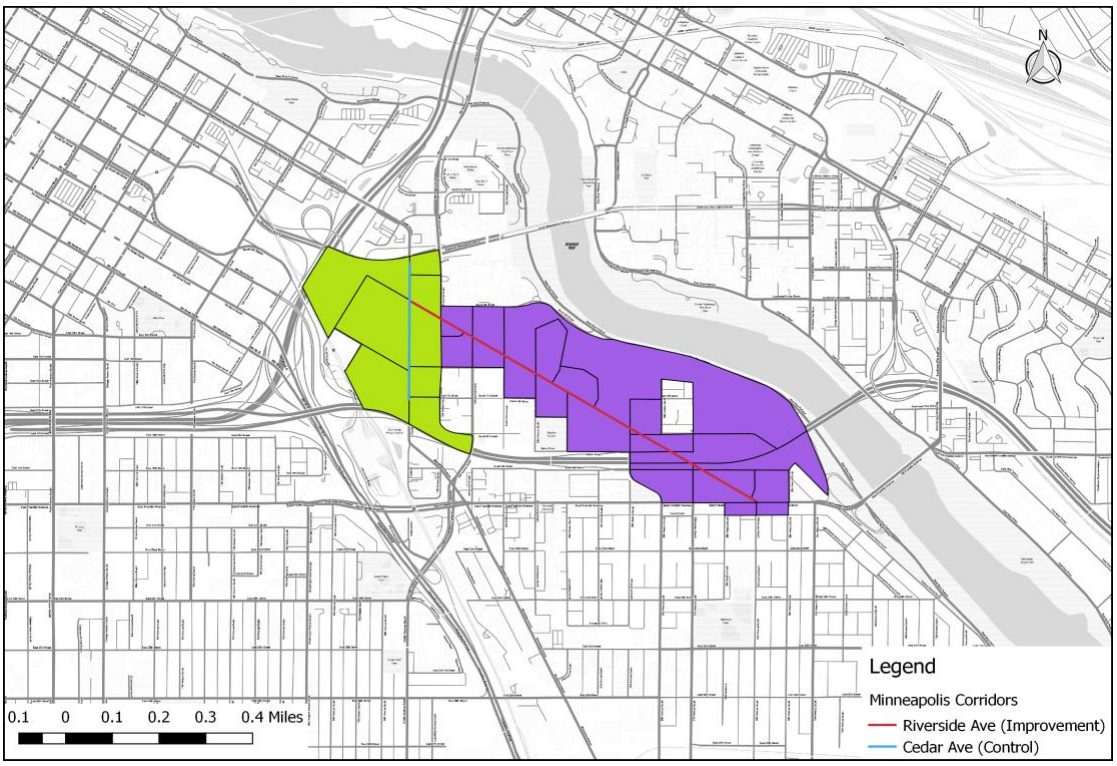

Figure 3-1. Riverside Avenue Corridor

Our first corridor group consists of the Riverside and Cedar Avenue corridors. Riverside Avenue was redesigned in 2009. The project involved redesigning Riverside Avenue from a street with four vehicular travel lanes to three vehicular travel lanes, adding curb extensions and bike lanes. The control corridor is Cedar Avenue, located near the treatment corridor. The Cedar Avenue comparison corridor is only 2,000 feet and covers three census blocks, and may be too small for meaningful comparisons.

The following table shows total, retail, and food employment for Riverside Avenue and Cedar Avenue, as well as the city-based percentile ranks of employment on the corridors. Although Riverside Avenue has more total employment, the two corridors 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. Riverside and Cedar Avenue Employment

	Employment per block			Percentiles		
Corridor	Total	Retail	Food	Total	Retail	Food
Riverside Ave.	345	18	7	85-90	80-85	60-65
Cedar Ave.	61	13	10	55-60	75-80	65-70

Statistically testing of all three metrics returned non-significant results, indicating that there is no statistically significant difference in the employment metrics between the street improvement and control corridors. This means that the corridors are comparable and are appropriate for the purposes of our analysis.

3.2 Franklin Avenue

Franklin Avenue's bike lane were installed in 2011 and involved the removal of a parking lane. The control corridor is designated as another segment of Franklin Avenue where the street improvement project was not constructed.

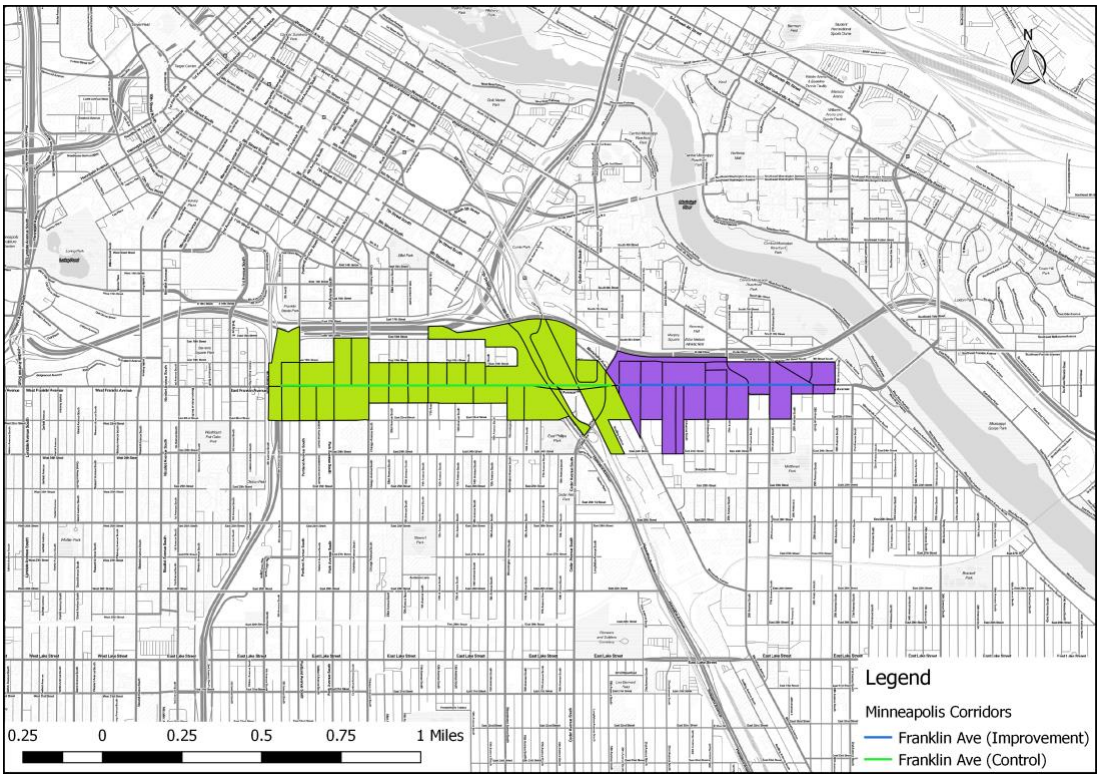

Figure 3-2. Franklin Avenue Corridor

The Franklin Avenue corridors both have total employment percentiles in the 60th percentile in the city and similar levels of food employment, but diverges when comparing retail employment percentiles. This indicates that there may be significant inherent differences (in addition to the street improvement treatment) in the industrial makeup or character of the two corridors that may contribute to differential economic outcomes.

Table 3-2. Franklin Ave. Corridors Employment

	Employment per block			Percentiles		
Corridor	Total	Retail	Food	Total	Retail	Food
Franklin (improvement)	59	8	8	60-65	70-75	60-65
Franklin (control)	103	1	5	70-75	40-45	55-60

We find that both corridors have statistically non-significant differences in "business" employment and their business employment share categories. However, the pre-construction retail and food employment growth rates are significantly different. In addition, because these corridors are on the same street corridor, they are not suitable for further DID analysis (this characteristic violates the independence assumption).

3.3 Central Avenue

In 2012, bike lanes were installed on Central Avenue by reducing the width of travel lanes. University Avenue NE, which is parallel to the treatment corridor, is selected as the control corridor.

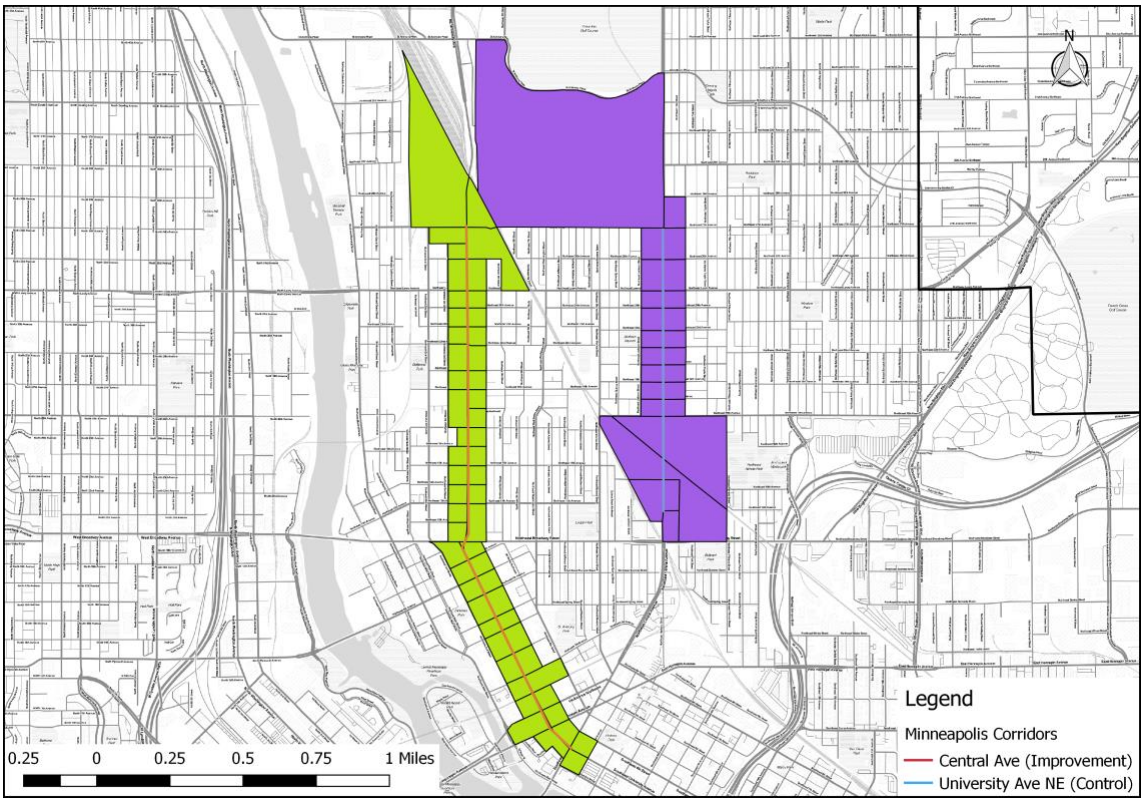

Figure 3-3. Central Avenue Corridor

Central Avenue corridors have total and retail employment in the 65-70th and 75-80th percentile of blocks in the city, respectively, which is slightly higher than control corridor University Avenue. However, University Avenue has more food employment than Central Avenue. In general, the two corridors has similar employment in terms of percentiles compared with the city.

Table 3-3. Central and University Avenue Corridors Employment

	Employment per block			Percentiles		
Corridor	Total	Retail	Food	Total	Retail	Food
Central Ave	77	10	5	65-70	75-80	55-60
University Ave	50	6	15	55-60	65-70	70-75

All t-tests, except food employment number, came back non-significant at the 0.05 level meaning that the two corridors are generally appropriate comparators.

3.4 Lyndale Avenue South

A road diet project was completed on Lyndale Avenue South in 2008. A motor vehicle travel lane was removed in each direction and a landscaped median, curb extensions, ADA upgrades, and pedestrian-scaled lighting was installed. Grand Avenue is selected as the control corridor, which is parallel to the treatment corridor.

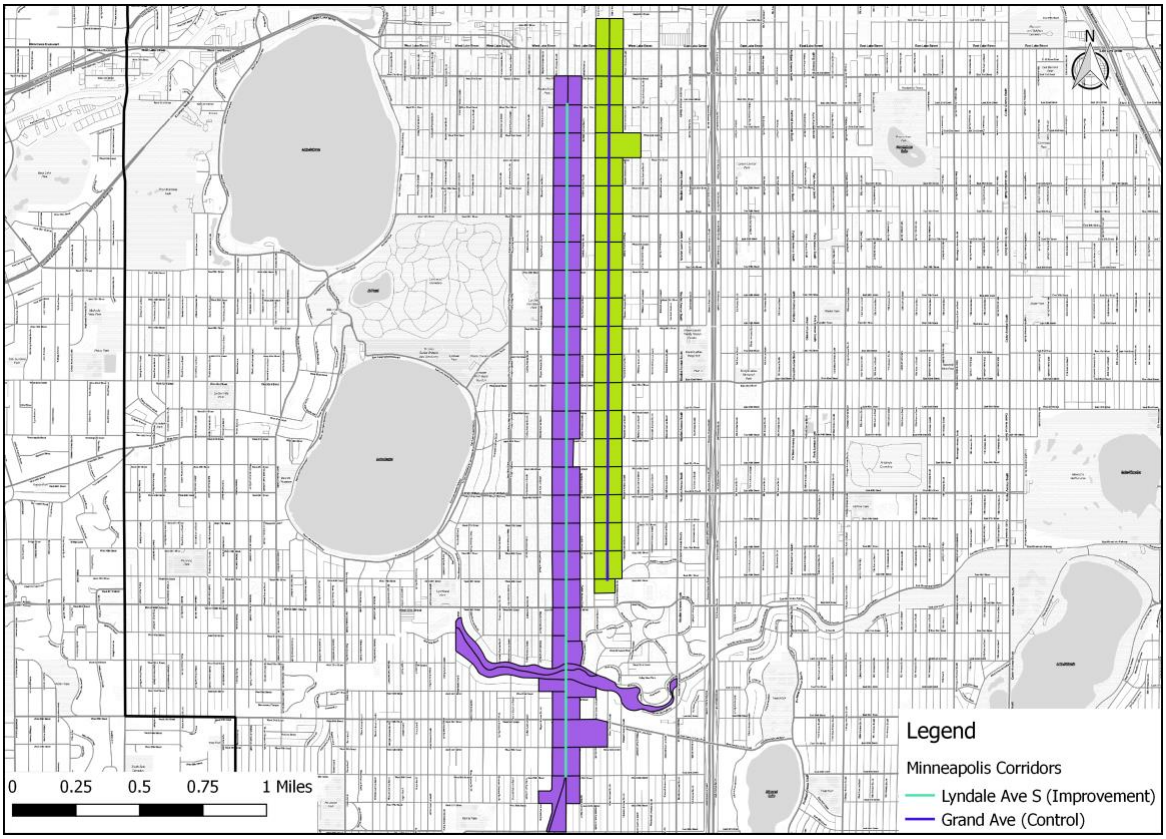

Figure 3-4. Lyndale Avenue South Corridor

Lyndale Avenue South and Grand Avenue diverge in terms of their percentile numbers across all employment categories with Lyndale Avenue South in the 50th percentile of total employment compared to the 25-30th percentile for Grand. Grand Avenue has much less employment than Lyndale Avenue South. However, all t-tests came back non-significant meaning that the corridors are still acceptable comparators, but results should be interpreted with attention to the context (where both corridors started with very low retail and food employment prior to the street improvement construction).

Table 3-4. Lyndale Avenue South and Grand Avenue Corridors Employment

	Employment per block			Percentiles		
Corridor	Total	Retail	Food	Total	Retail	Food
Lyndale	41	7	4	50-55	60-65	50-55
Grand	12	1	1	25-30	30-40	45-50

3.5 North Second Street

Bike lanes were installed on North Second Street in 2011, requiring the removal of a parking lane and width reduction of existing motor vehicle travel lanes. West Broadway Avenue is selected as the control corridor.

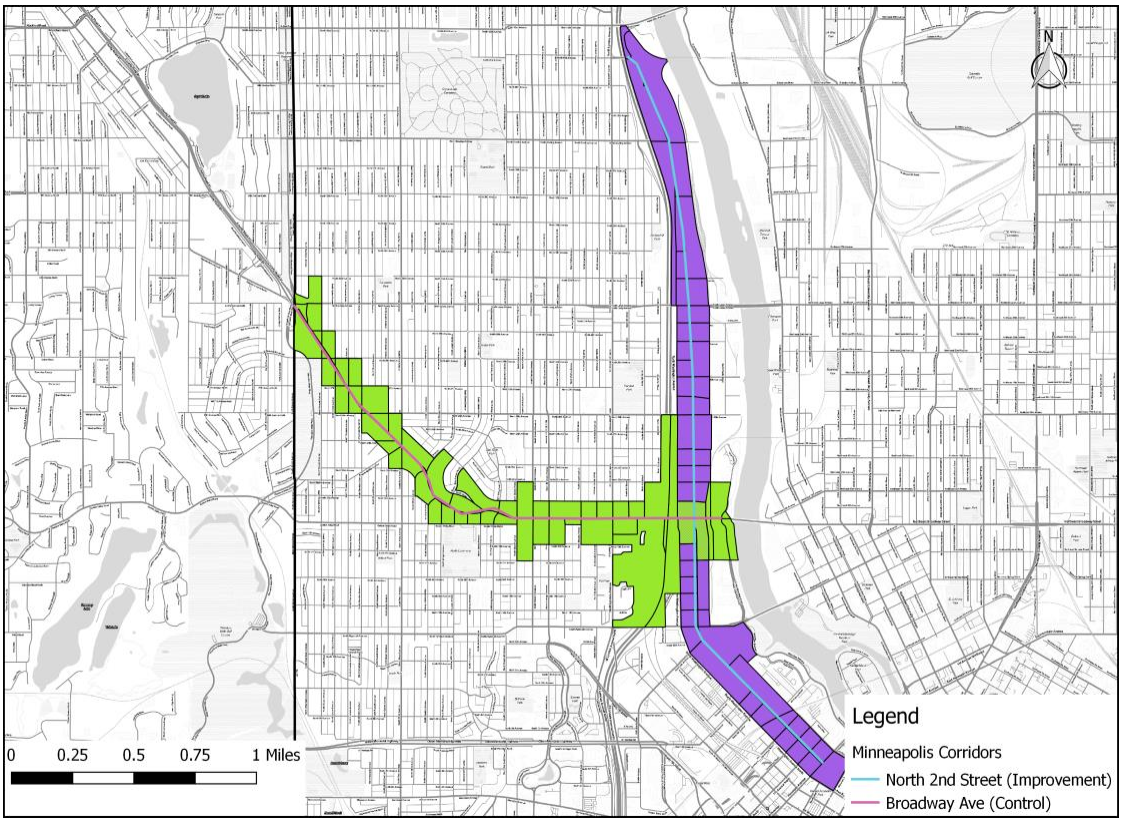

Figure 3-5. North Second Street Corridor

Although North Second Street has more total employment than West Broadway Avenue, the difference narrows when focusing in on retail and food employment, which are the industries of interest for this analysis.

Table 3-5. North Second Street and West Broadway Avenue Corridors Employment

	Employment per block			Percentiles		
Corridor	Total	Retail	Food	Total	Retail	Food
Second St.	132	5	7	75-80	55-60	60-65
Broadway	36	7	5	50-55	65-70	55-60

Both t-tests on business employment numbers and the pre-construction employment growth rates metrics returned non-significant results, indicating that the corridors are acceptable comparators. However, the business share metrics were significantly different, suggesting that DID analysis may not be appropriate for this corridor pair.

3.6 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. Note that Franklin Avenue appears to be the least comparable with its control corridor, and also fails an independence assumption required for DID analysis since the corridors are different sections of the same street. And thus we exclude the DID analysis for the Franklin Avenue corridor, but proceed with the other analysis methods.

Table 3-6. Corridor Comparison Summary

Treatment Corridor	Indicator		**Riverside**	**Franklin**	**Central**	**Lyndale**	**North Second**
Control Corridor			Cedar	Franklin	University	Grand	Broadway
Transportation/ Geography	Geographic Proximity		✓	×	✓	✓	✓
	Street Classification		✓	✓	✓	✓	✓
	Role in Street Network		✓	✓	✓	✓	✓
Business Activity	Job Density Percentile	retail	✓	✓	✓	✓	✓
		food	✓	✓	×	✓	×
	Share of Business Jobs		✓	✓	✓	✓	×
	Employment Growth Rate	retail	✓	×	✓	✓	✓
		food	✓	×	✓	✓	✓

4. Data Analysis

4.1 Riverside Avenue

4.1.1 Aggregated Trend Analysis

4.1.1.1 LEHD

On Riverside Avenue, the retail employment trends seem to suggest a possible positive effect of the bike infrastructure installation with a major jump in employment in the two years immediately after construction, and positively trending employment growth subsequent to the initial jumps. The comparison corridor's (Cedar Avenue) employment remains basically unchanged, and follows the overall trends in the City of Minneapolis, except for a minor bump between 2010 and 2011.

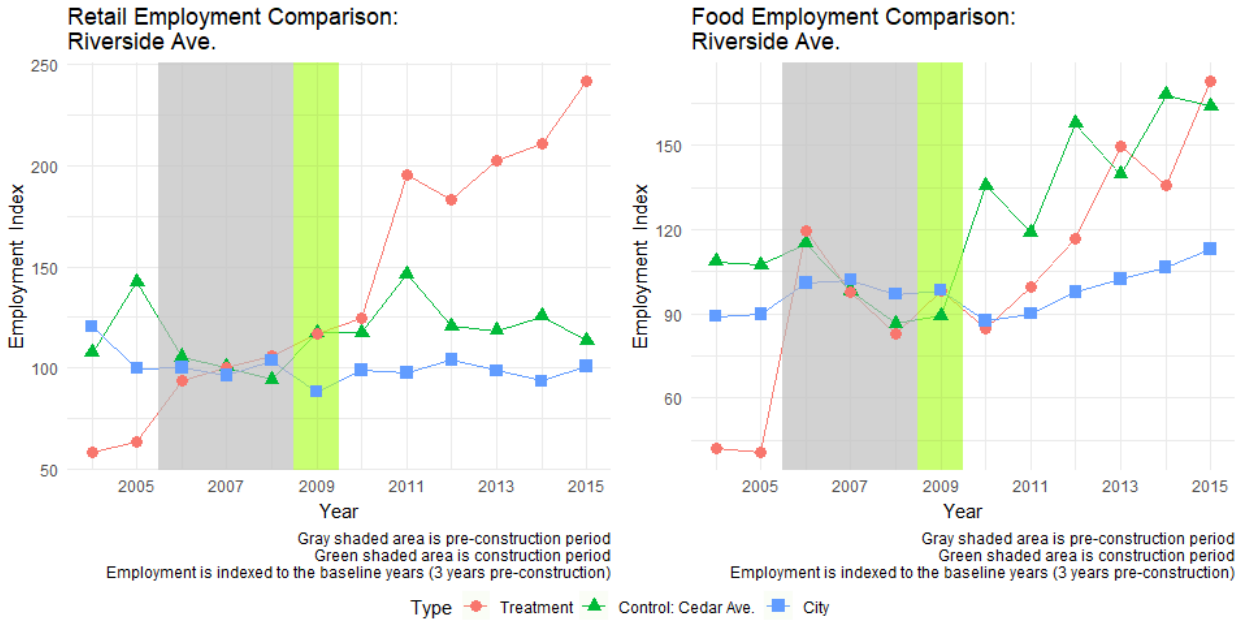

Figure 4-1. Riverside Avenue Employment Comparison (LEHD)

The Riverside Avenue food service employment patterns are more mixed. Employment growth for the improvement corridor is more robust and consistent after construction compared to the control corridor, and food employment in both corridors outperform the city as a whole. The trend analysis here suggests a potential positive effect of the infrastructure construction, but given that the control corridor is also experiencing positive growth, it is unclear whether the growth on Riverside Avenue can be attributed to the street improvement.

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.

In terms of retail sales, Riverside Avenue remains consistently lower than Cedar Avenue both in absolute terms and in growth rates over time. We can observe Cedar Avenue retail sales growing consistently over time, while Riverside Avenue experienced a drop in retail sales revenue, followed by a minor recovery, and declining sales growth post-construction that is only now recovering.

While Cedar Avenue is the dominant corridor in terms of retail sales, both corridors track each other much more closely when examining restaurant sales tax receipts. Both Cedar and Riverside Avenues have consistent positive growth over the entire study period, with significant jumps in the rate of growth immediately post-construction.

Comparing the trends for the Riverside Avenue corridor group, it is not immediately apparent that the construction had any discernable impact on retail or restaurant sales. In both cases, the treatment and control corridors largely follow each other in terms of growth, except for a dramatic drop and recovery in retail sales on Riverside Avenue between 2013 and 2014. Given the sensitivity of sales tax as a measure, it is unlikely that the drop and subsequent recovery are reactions to the street improvement construction completed years before. In the case of restaurant sales, both corridors experienced dramatic growth, though the rate of growth on the Riverside Avenue corridor is more modest, and sales activity in the food industry grew significantly in both corridors after the construction year.

The indexed plots give us an alternative view of the corridors that reinforce what the non-indexed plots show, by highlighting how the economic indicators have changed when compared to the baseline year of 2009 when the street improvement occurred. The consistent growth of the retail sector on Cedar Avenue and the relatively weaker growth on Riverside Avenue are evident in the indexed plots. It is clear that Riverside Avenue has yet to recover to its 2009 levels, in terms of retail sales. However, the restaurant sales indexed plot tracks the non-indexed plot more closely because both corridors have grown consistently over time.

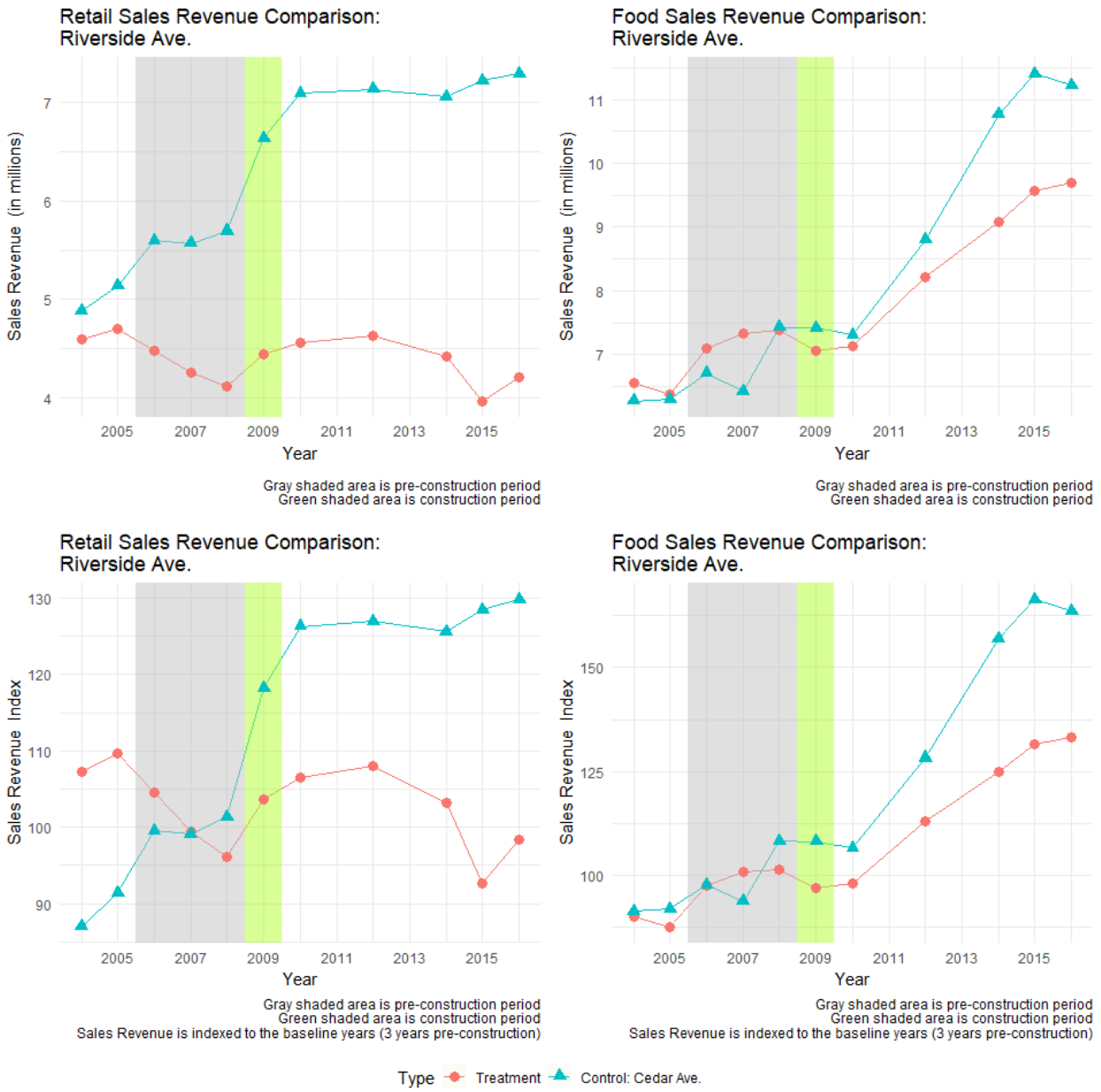

Figure 4-2. Riverside Avenue Sales Revenue Comparison (Sales tax data)

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 Riverside Avenue aggregated trend analysis shows that there was a large jump in retail activity on the corridor during the first quarter of 2005, with consistent overall growth in employment and wages. This large jump in growth was related to the addition of a new,

large establishment on the corridor as the total number of retail establishments grew from 4 to 5 in 2005. This large establishment is a clear driver in the growth of employment and wages. Also, note that there does not seem to be any immediately apparent relationship in employment or wage growth and the infrastructure construction period.

Figure 4-3. Riverside Avenue Employment and Total Wages Comparison (QCEW)

The indexed employment and wage figures offer a clearer picture of the dramatic growth of Riverside Avenue, even accounting for the large jump in employment in 2005. Principally, note that retail employment growth for Riverside and Cedar Avenues has recovered to 2009 levels with Riverside Avenue showing robust growth post-recession and a flattening in the past three years. Cedar Avenue, on the other hand, has steadily lost employment post-recession after a large bump and is also now hovering around its 2009 employment levels.

Wage growth, though, for both corridors has been on a largely positive trajectory from even before the construction period, though the street improvement corridor has seen higher wage growth, relative to its 2009 base year, than the control corridor. Again, note

that there does not seem to be any immediately evident connection between wage growth and the corridor construction.

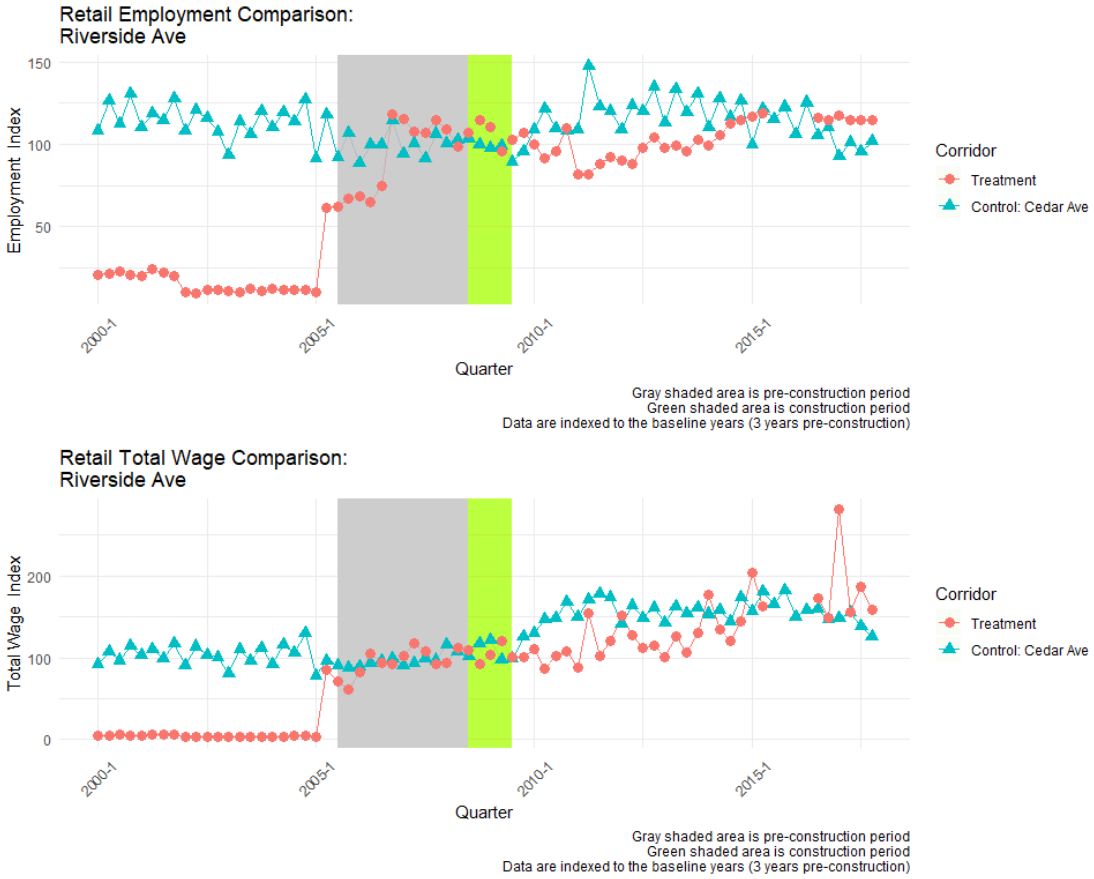

Figure 4-4. Riverside Avenue Indexed Employment and Total Wages Comparison (QCEW)

Table 4-1. Riverside 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	293	6.17%	24.23%	57.14%	-6.12%	25.09%	150	-16.75%	-15.33%	17.32%	17.45%	6.48%
Control: Cedar	100	-5.38%	17.00%	24.79%	-17.81%	7.99%	77	-13.22%	36.36%	-12.38%	32.61%	18.86%
Sales: [sales revenue, $]												
Treatment	4,280,587	-4.10%	6.44%	1.51%	-4.47%	1.16%	7,273,965	1.94%	-1.94%	15.23%	10.54%	7.94%
Control: Cedar	5,619,758	0.90%	26.28%	0.54%	-1.08%	8.58%	6,855,862	5.68%	6.65%	20.31%	22.33%	16.43%
QCEW: [employment]												
Treatment	198	16.40%	-0.59%	-13.25%	10.44%	-1.13%	-	-	-	-	-	-
Control: Cedar	119	0.60%	12.32%	11.53%	-2.52%	7.11%	-	-	-	-	-	-

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. In general, the LEHD data shows positive impact of the bike lane installation on retail service employment on the treatment corridor, but not on food services. However, sales tax data shows a different trend that indicates retail sales dropped significantly, while restaurant sales increased greatly. QCEW data shows some mix trends in retail employment: the control corridor grew faster than treatment corridor right after street improvement, but the treatment corridor growth rate exceeded that of the control corridor two years after the street improvement. The mixed trends in sales and employment might be attributed to a transition in the types of businesses on the corridors, perhaps a transition towards types of new establishments that can generate higher sales receipts with fewer employees.

4.1.2 DID Analysis

DID analysis of LEHD data indicates the Riverside Avenue treatment corridor exhibits a statistically significant and positive effect of infrastructure construction on the number of retail jobs and a positive, but non-significant, effect on food employment. According to our model, Riverside Avenue grew by more than 285 jobs in total compared to the control corridor.

In terms of sales tax, the corridor shows some mixed results. The *pre_post* construction term is positive and significant for both restaurant and retail showing positive sales tax receipt growth post-construction, but the difference term is negative and significant for retail sales signaling a negative impact of the new construction on retail sales tax receipts. This result largely mirrors what we saw in the visual aggregated trend analysis with that

dramatic drop in sales in 2013 and 2014. Given that drop is well after construction there are likely additional reasons for the drop than just the placement of new infrastructure.

The QCEW DID results largely parallel the LEHD results. According to our specification, there is a negative and significant effect of infrastructure construction on average employment and total wages. This indicates Riverside Avenue grew by more than 105 jobs and $2,280,422 in total wages overall compared to the control corridor.

4.1.3 ITS Analysis

ITS analysis of the Riverside Avenue corridor using LEHD data does not show any significant level or slope change from the pre-treatment trend patterns. While the ts_year coefficient for retail is positive and significant this only tells us that the growth trend of retail employment for the corridor is itself positive. The non-significant **prepost** and **ts_year:pre_post** indicate that there was neither a level or slope change attributable to the treatment.

In terms of sales tax data results, the non-significant results from the *ts_year:pre_post* term gives some supportive evidence that the construction was not directly responsible for the drop in sales tax receipts for the corridor that the DID highlighted. Overall, it seems unlikely there is a clear causal relationship between the corridor construction and employment or sales tax effects.

The QCEW ITS estimates are mixed. For employment, the ITS estimates show a positive and significant change in the level of employment but a negative slope. This follows from the visual inspection of employment that shows a clear jump in 2005 but relatively flat to slightly negative growth after the construction period. For wages, both the level and slope change variables are non-significant.

4.1.4 Key Results

- The LEHD data analysis shows the positive impact of the bike lane installation on retail service employment on the treatment corridor, based on the aggregated trend analysis and DID approach. The ITS approach shows that the rapid increase of retail service employment is largely attributed to overall economic growth in the region, as opposed to impacts from street improvement.
- LEHD data shows food service employment grew more gradually after the bike lane installation. However, the two rigorous econometric approaches, DID and ITS, both indicate that the increase in food service employment may not be attributed directly to the street improvement on this corridor.
- Sales tax data reflects some different trends: retail service related sales significantly dropped after bike lane installation, while restaurants sales increased greatly. This was also seen in the ITS analysis. We suspect a shift from retail businesses towards more food service establishments on Riverside Avenue after the street improvement.
- The divergence between trends in the employment data and retail sales data might be due to differences in the actual business activities that are captured by the two datasets. Some categories of retail sales, such as clothing and unprepared food, are

tax exempted in Minnesota, and would not be reflected in sales tax revenue data, but LEHD data covers all employment within the retail sector. On the other hand, LEHD includes employment in both food services and accommodation, whereas sales tax revenues will only capture restaurant sales.

- Given these mixed results, our analysis was inconclusive for Riverside Avenue.

4.2 Franklin Avenue

4.2.1 Aggregated Trend Analysis

4.2.1.1 LEHD

Retail employment increased greatly right after street improvement, and kept consistent, though moderate, growth for the improvement corridor. While the control corridor lagged in retail employment growth during this same period, it does experience a dramatic spike in starting in 2014, but is unlikely related to the street improvement event. However, we observe that Franklin Avenue, on both the treatment and control corridor, have greater growth in retail employment than the city as a whole.

In terms of food employment, the trend analysis is relatively ambiguous. In the post-construction period after 2011, both the improvement and control corridor food employment remained flat to slightly negative. This situation does not change until the dramatic spike that occurs on the improved portion of Franklin Avenue, but given the timing, it is also unlikely the construction itself is responsible for this dramatic change.

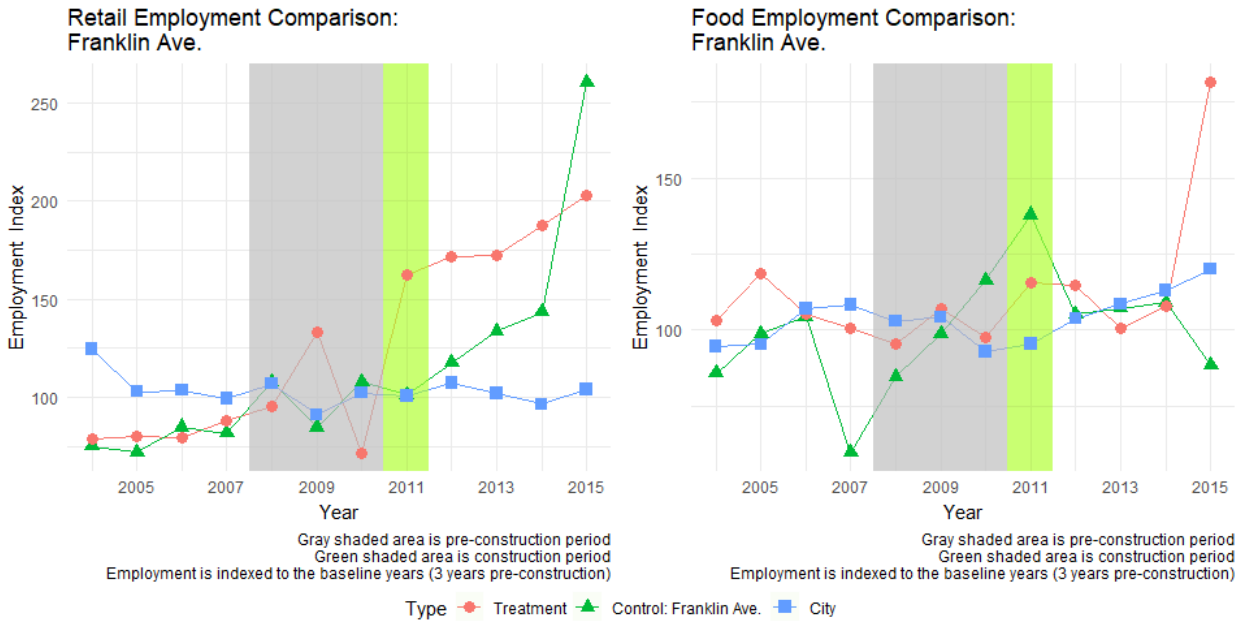

Figure 4-5. Franklin Avenue Employment Comparison (LEHD)

4.2.1.1 Sales Tax

The format of the data prevented us from parsing out which portions of sales revenue belonged to which portion of Franklin Avenue due to their proximity, so this sales tax analysis is excluded from the study.

4.2.1.1 QCEW

Analysis of the more accurate QCEW data indicates that the treated section of the Franklin Avenue corridor has significantly more retail employment and retail wages than the control area, but note the accelerated change in slope on the treated section a little before 2010 that carries through the construction period and finally moderates and drops in the last few quarters. This is in comparison to the relatively flat overall growth of the control section.

Figure 4-6. Franklin Avenue Employment and Total Wages Comparison (QCEW)

The following indexed figures for both total wages and average employment growth show the two corridors tracking each other closely in terms of growth rates, with a slight divergence in later quarters for the treated section of the corridor. This follows logically

given the fact that these are two sections of the same stretch of street. That being said, the corridor has seen robust, consistent growth over time, though it is not immediately apparent if the infrastructure construction had a clear effect from the trend analysis alone.

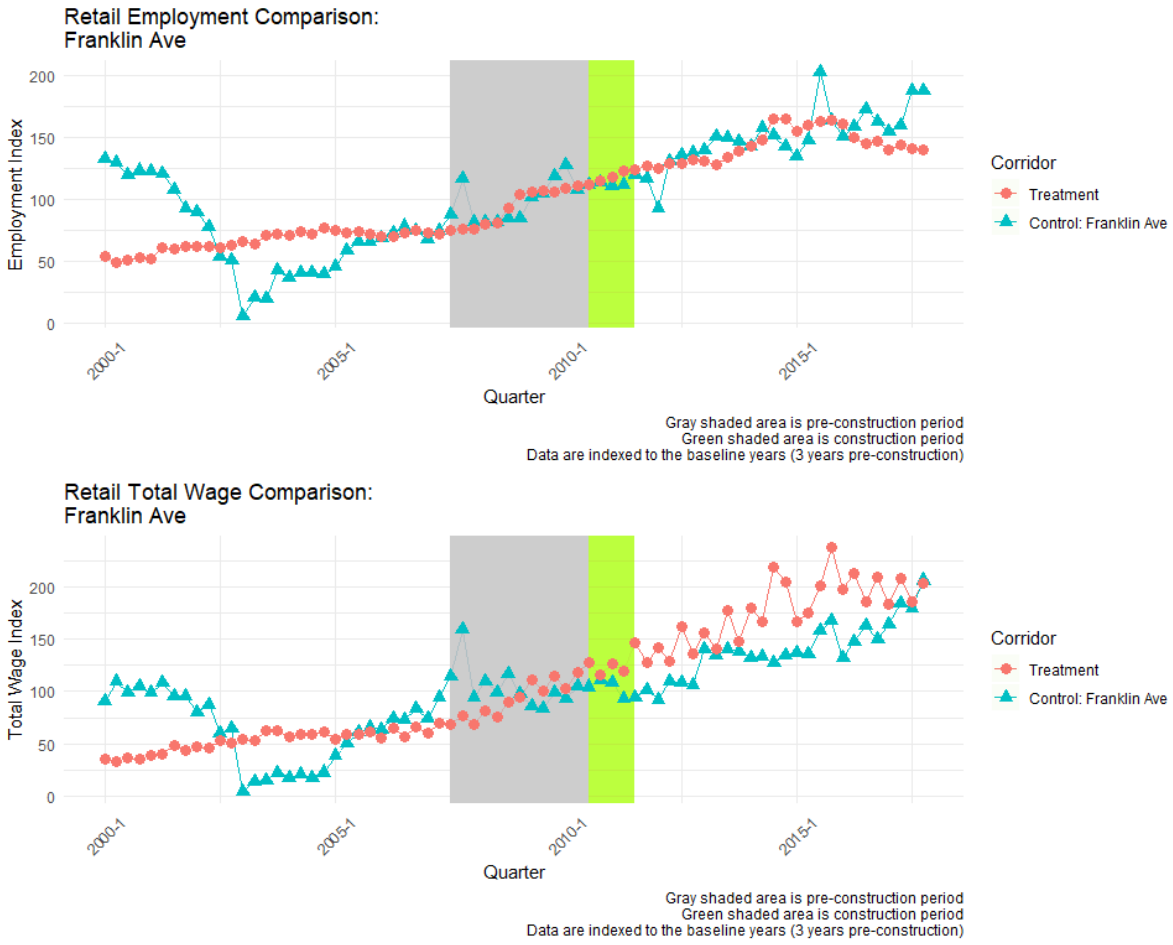

Figure 4-7. Franklin Avenue Indexed Employment and Total Wages Comparison (QCEW)

Table 4-2. Franklin Corridor Trend Analysis Summary Table

Area	Retail						Food					
	Baseline		Post-implementation				Baseline		Post-implementation			
	Base	Growth	1st Year	2nd Year	3rd Year	Avg.	Base	Growth	1st Year	2nd Year	3rd Year	Avg.
LEHD: [employment]												
Treatment	169	-3.24%	71.60%	0.34%	8.93%	26.96%	130	1.73%	14.62%	-12.08%	6.87%	3.14%
Control: Franklin	31	2.86%	16.13%	13.89%	7.32%	12.44%	107	17.20%	5.61%	1.77%	1.74%	3.04%
QCEW: [employment]												
Treatment	214	16.90%	28.89%	3.23%	16.68%	16.27%	-	-	-	-	-	-
Control: Franklin	44	18.32%	23.67%	18.07%	1.30%	14.45%	-	-	-	-	-	-

[1] Baseline is defined as the average of previous three years before construction year;
[2] Pre-growth rate is defined as average of baseline annual growth rate;
[3] 1st year growth rate is defined as the growth rate of the year after construction compared to baseline.

The table above summarizes the detailed percentage changes of retail and food services economic indicators across two different data sources. Retail employment growth is observed in the street improvement segment of Franklin Avenue, at a faster rate than the control corridor, based on both LEHD and QCEW data. In addition, QCEW data indicates total wages in the retail sector also appear to be growing at a faster pace in the improvement.

4.2.2 DID Analysis

We did not perform a DID estimation for Franklin Avenue, as the corridor comparison process showed that the corridor group to be unsuitable for this type of analysis.

4.2.3 ITS Analysis

We found some mixed results when conducting ITS analyses on the Franklin Avenue treatment and control corridors. The street improvement corridor lost a significant number of food service jobs, indicated by the large, negative and statistically significant change in level seen of the **prepost** coefficient, but also a positive shift in the *slope*. This is seen visually in the aggregate employment chart (Figure 4-5) for food employment on the improved Franklin Avenue corridor where there is a clear drop in employment after construction (negative change in level) and then a sizable growth in employment between 2014 and 2015 (positive shift in slope). Due to a lack of further data points beyond 2015, it is unclear whether this rise will taper off, creating a new, higher level of employment, but it does seem likely that the corridor potentially has a positive shift in food employment.

ITS models were not run for Franklin using the sales tax data due to the aforementioned data issue.

The QCEW ITS models largely do not find an effect of construction except for the slope change term for total wages. In the case of total wages, the ITS estimate finds a positive significant value. But considering that the employment model is non-significant across all terms and the level change term is negative and non-significant for wages, this does not support a causal relationship between new cycling infrastructure and retail employment or wages.

4.2.4 Key Results

- Retail employment growth is observed in the street improvement segment of Franklin Ave, at a faster rate than the control corridor, based on LEHD data. In addition, QCEW data indicates total wages in the retail sector also appear to be growing at a faster pace in the improvement corridor, possibly indicating a shift in the type of retail businesses that are located in this area.
- Although retail employment increased after bike lane installation, the evidence from the ITS approach from the two data sources shows a statistically non-significant causal relationship between the bike lane installation and employment growth.
- LEHD data shows food employment greatly increased two years after bike lane installation, exceeding the growth rate of both the control corridor and greater city trends. Both the trend analysis and ITS approach show a positive trend.
- In conclusion, the bike lane on Franklin Avenue triggered a significant employment increase in the food services industry approximately two years after installation, indicating an improvement in business vitality as a result.

4.3 Central Avenue

4.3.1 Aggregated Trend Analysis

4.3.1.1 LEHD

Central Avenue shows a clear positive retail employment trend post-construction that eventually outpaces the growth on control corridor in 2015. Note that both corridors experienced positive employment trends during the post-construction period, and have more or less performed better than the city as a whole.

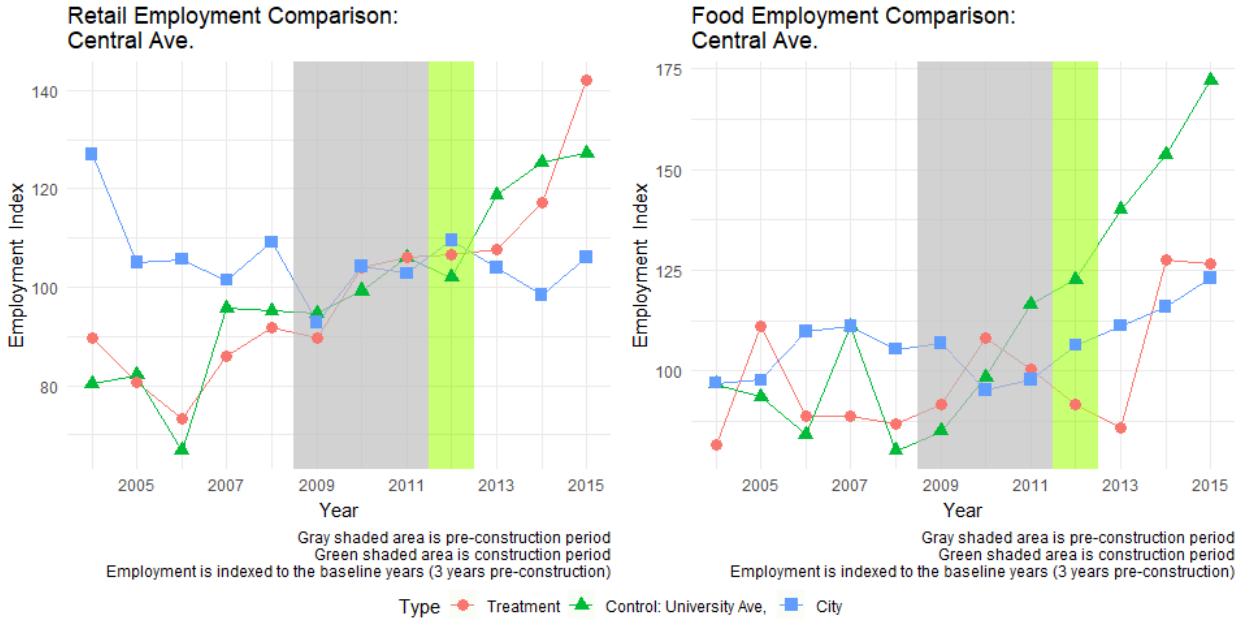

Figure 4-8. Central Avenue Employment Comparison (LEHD)

The food employment trend on Central Avenue is less obvious. The treatment corridor saw large increases in employment immediately following the post-construction period that has started to outpace food employment in the city, but the University Avenue control corridor has seen a consistently larger trend of growth in the same sector since 2009. Given these results in the aggregated trend analysis of the QCEW data combined with the short post-construction period, we are unable to draw clear conclusions of the impact of the infrastructure on food employment here.

4.3.1.1 Sales Tax

The aggregated trend analysis of sales tax receipts on Central Avenue indicate some positive impacts of the bike lane installation on business vitality. While Central Avenue's sale receipts grew in both retail and restaurant sectors, the positive growth trends for both industries start either before or at the beginning of the construction period. In particular, retail sales revenue appears to grow over the time period of analysis, while retail sales revenue on the control corridor is dropping. The rate of change in growth, though, in restaurant receipts on the treatment corridor appears to quickly accelerate post-

construction. While not definitive, this acceleration in growth in the food industry hints at potential positive impacts that our econometric models will explain more clearly.

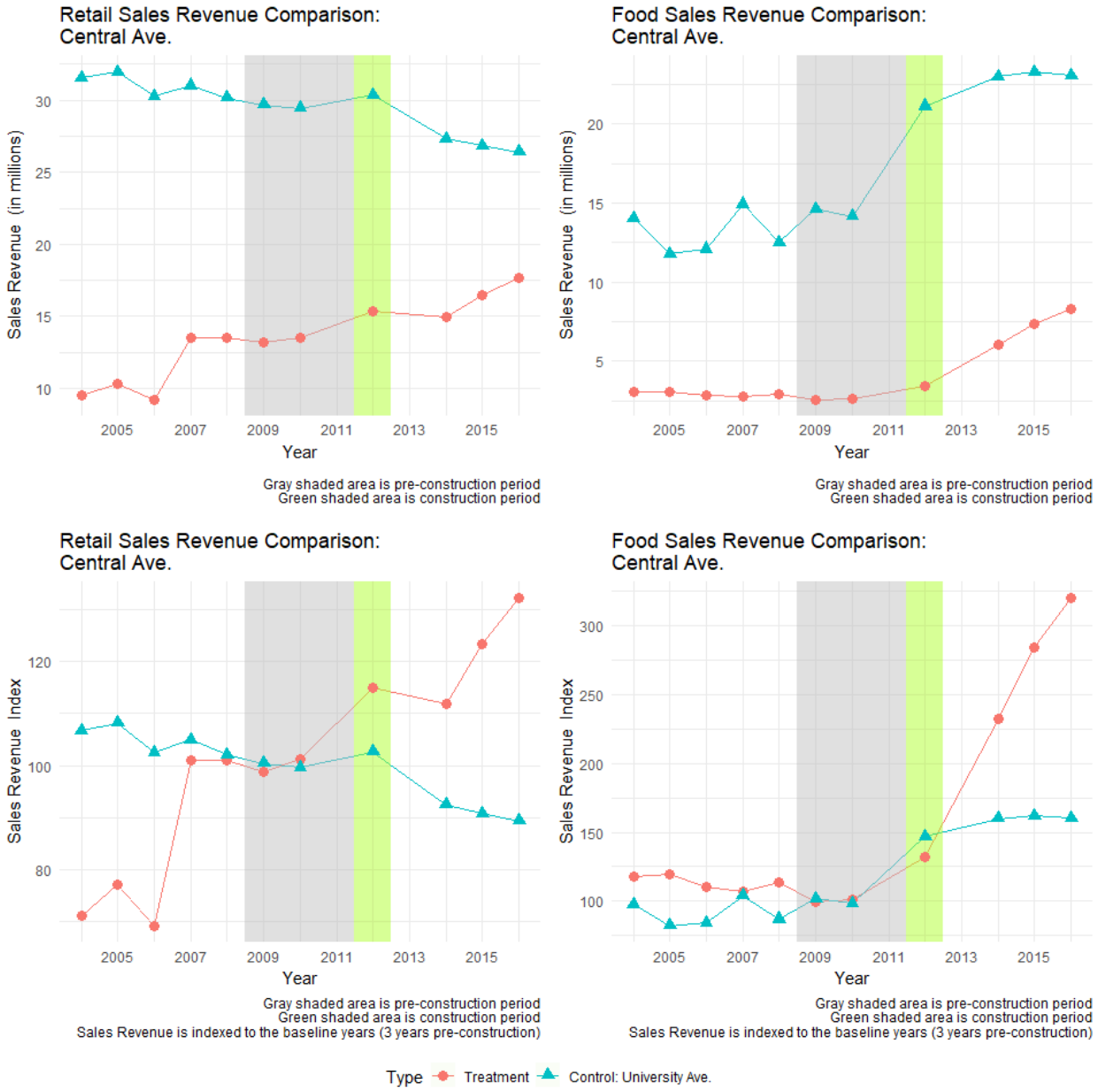

Figure 4-9. Central Avenue Sales Revenue Comparison (Sales Tax Data)

The index value plots bring the differences between growth rates between the treatment and control corridors into stark relief. Central Avenue has fared much better over the course of the study period, exhibiting robust growth in both retail and restaurant sales. The post-construction growth bump is especially apparent in the restaurant sales indexed plot. University Avenue's flattened growth in both restaurant and retail sales is especially striking in comparison to university's consistent growth.

4.3.1.1 QCEW

Central Avenue retail employment change was highly volatile in the early part of the 2000s, maintaining a level of around 200 jobs immediately before and through the recession. In the past few years, retail employment along this corridor has seen fairly dramatic growth. University Avenue, on the other hand, lost a large number of jobs during the same period, but saw a spike in employment around 2012. The total wages paid on the two corridors largely mirror the employment levels directly. The aggregated trend analysis of the QCEW data indicate that there is not an immediately apparent connection between the street improvement and employment or wage levels on Central Avenue.

Figure 4-10. Central Avenue Employment and Total Wages Comparison (QCEW)

The index plots show dramatic growth on both Central and University Avenues over the past decade and a half with respect to both retail employment and wages. One detail to note is that Central Avenue continues on its positive trajectory for both wages and employment in the last few years, and ultimate surpasses the much more volatile University Avenue in terms of growth.

Figure 4-11. Central Avenue Indexed Employment and Total Wages Comparison (QCEW)

Table 4-3. Central 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	189	8.96%	7.94%	8.82%	21.17%	12.64%	103	5.44%	-14.56%	48.86%	-0.76%	11.18%
Control: University	222	5.79%	18.47%	5.70%	1.44%	8.54%	393	17.11%	39.95%	9.82%	12.09%	20.62%
Sales: (sales revenue, $)												
Treatment	13,406,600	0.18%	11.60%	10.25%	7.17%	9.67%	2,703,133	-5.64%	122.44%	22.13%	12.76%	52.44%
Control: University	29,758,008	-1.19%	-8.21%	-1.77%	-1.58%	-3.85%	13,767,338	6.83%	67.12%	1.38%	-1.13%	22.46%
QCEW: (employment)												

Treatment	209	1.50%	0.64%	0.99%	4.98%	2.20%	-	-	-	-	-	-
Control: University	152	-20.28%	37.01%	27.85%	-5.35%	19.84%	-	-	-	-	-	-

[1] Baseline is defined as the average of previous three years before construction year;
[2] Pre-growth rate is defined as average of baseline annual growth rate;
[3] 1st year growth rate is defined as the growth rate of the year after construction compared to baseline.

The table above summarizes the detailed percentage changes of retail and food services economic indicators across three different data sources. Retail and food service employment on Central Avenue increased after bike lane construction, but mostly at a pace on par with the control corridor. Retail sales in the treatment corridor increased faster than the control corridor, and there is dramatic increase of restaurant sales after bike lane installation.

4.3.2 DID Analysis

DID analysis of LEHD data on the Central Avenue treatment corridor showed a significant and negative impact on food employment, and a non-significant impact on retail employment. These results are indicative of the drop in food employment that we observed through our aggregated trend analysis of the same data, and the more robust growth in employment on the control corridor over time.

In terms of sales tax, the DID analysis on Central Avenue shows mixed results of the street improvement. The estimated difference coefficient for restaurant sales is negative and significant while the coefficient for retail sales is positive and significant. Overall, this model specification implies that an additional $7 million in retail sales tax receipts and a loss of $5.7 million in restaurant receipts may be attributed to the street improvement. This shift possibly indicates that the new infrastructure construction on Central Avenue contributed to an industrial shift from food services establishments to retail along this corridor. However, the analysis is unable to provide us with the reason underlying this shift, and an examination of the context of the street improvement or other factors on the corridor may be needed.

The QCEW DID estimates for wages and employment both returned non-significant results. This makes intuitive sense when examining the employment and wage figures from the aggregated trend analysis. While there appears to be growth in wages and employment, it is not clear that growth in either economic indicator can be attributed to the construction of the bike lane.

4.3.3 ITS Analysis

ITS analysis of the LEHD data on Central Avenue also showed mixed results, but this may be due to the limited number of data points after construction that is available. According to this model specification, Central Avenue retail employment saw a negative, statistically significant drop in employment level after treatment, but there is a positive slope signaling an overall positive growth trend. Again, combining these results with the aggregated trend analysis of employment, it becomes clear that while Central Avenue experienced lower

retail employment post-construction, but greater growth (slope), indicating a positive trajectory. There is similar trend in food services employment, indicating that Central Avenue saw a lower level of food employment post-construction but with greater growth rate (slope).

The sales tax ITS analysis shows the *ts_year:pre_post* term is significant and positive for restaurant sales, but non-significant for retail sales. Also note the large, negative and significant *pre-post* term for restaurant sales, which is similar to our analysis of the LEHD employment data which shows that there was a drop in activities in the food services industry after the construction, but this lower level is coupled with a positive growth trajectory. The impact of the street improvement on Central Avenue should become clearer as additional data points become available in the future.

The QCEW ITS models for Central Avenue offer a mixed set of conclusions. For employment, the ITS has a negative and significant result for the level change but a non-significant result for a slope change. The wage model, on the other hand, shows a negative and significant result for the *pre_post* term and a positive and significant result for the *ts_year:pre_post* term showing a negative change in level but positive change in slope post construction.

4.3.4 Key Results

- Retail and food service employment on Central Avenue increased after bike lane construction. Both the trend analysis and the DID models show evidence that the growth in employment on Central Avenue is on par with the control corridor. In addition, the ITS approach shows a positive growth trend impact of bike construction using LEHD data and QCEW wages data.
- In terms of sales data, the aggregated trend analysis approach shows that retail sales in the treatment corridor increased faster than the control corridor. However, additional econometric analyses suggest the impact is not statistically significant.
- There is a very apparent trend that restaurant sales on Central Avenue increased dramatically following bike lane installation. Both trend analysis and the ITS approach confirm the positive impact of bike lane installation on restaurant sales on Central Avenue.
- In conclusion, on Central Avenue, we found a significant positive impact on restaurant sales following bike lane construction, indicating an improvement in business vitality.

4.4 Lyndale Avenue South

4.4.1 Aggregated Trend Analysis

4.4.1.1 LEHD

The street improvement on Lyndale Avenue South coincided with the recession of 2008. As such, many of the economic indicators may be showing some recessionary impacts and subsequent recovery. While both Lyndale Avenue South and its corresponding control corridor have been struggling to recover to its pre-recession retail employment levels, they both saw a spike in retail employment in 2015. This generally shows that the stagnant growth in retail employment in the past years is not attributable to the street improvement construction, since the retail employment trends on both corridors do not appear to be drastically different. In terms of food employment, the treatment corridor also shows no sign of employment impacts due to construction, maintaining a level of low growth consistent with city-wide growth, but at a much lower level than Grand Avenue.

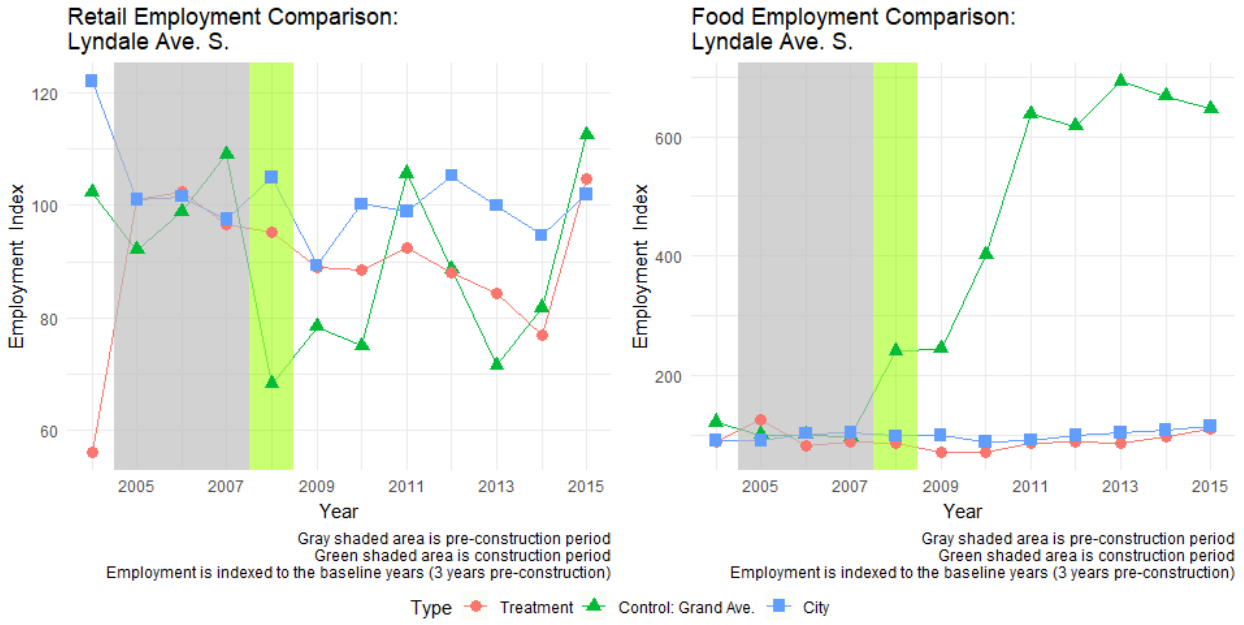

Figure 4-12. Lyndale Avenue Employment Comparison (LEHD)

4.4.1.1 Sales Tax

The Lyndale Avenue corridor also displays ambiguous impacts of the new cycling infrastructure on retail and restaurant sales. There is a minor bump post construction for retail that results in increased growth over time signaling a possible effect of construction. Restaurant sales growth, though, is clearly tied to an external major increase in demand nearly a decade after construction. Additionally, the growth in restaurant sales tax receipts was less than that of its control corridor both in absolute and relative terms.

The indexed plots echo the conclusions seen in the absolute value plots. In particular, notice the dramatic decline of retail sales for Grand Avenue compared to the modest, but steady, growth in receipts on Lyndale Avenue South. Restaurant sales grow at a faster rate on Grand Avenue than Lyndale Avenue South, until the final year where the street improvement corridor experiences a dramatic boost in growth. But as mentioned earlier, these graphs do not provide compelling visual clues as to the effect of new street improvement on sales tax receipts. The most that we can conclude from this aggregated trend analysis of sales tax data is that the construction did not appear to impede business activities along Lyndale Avenue South.

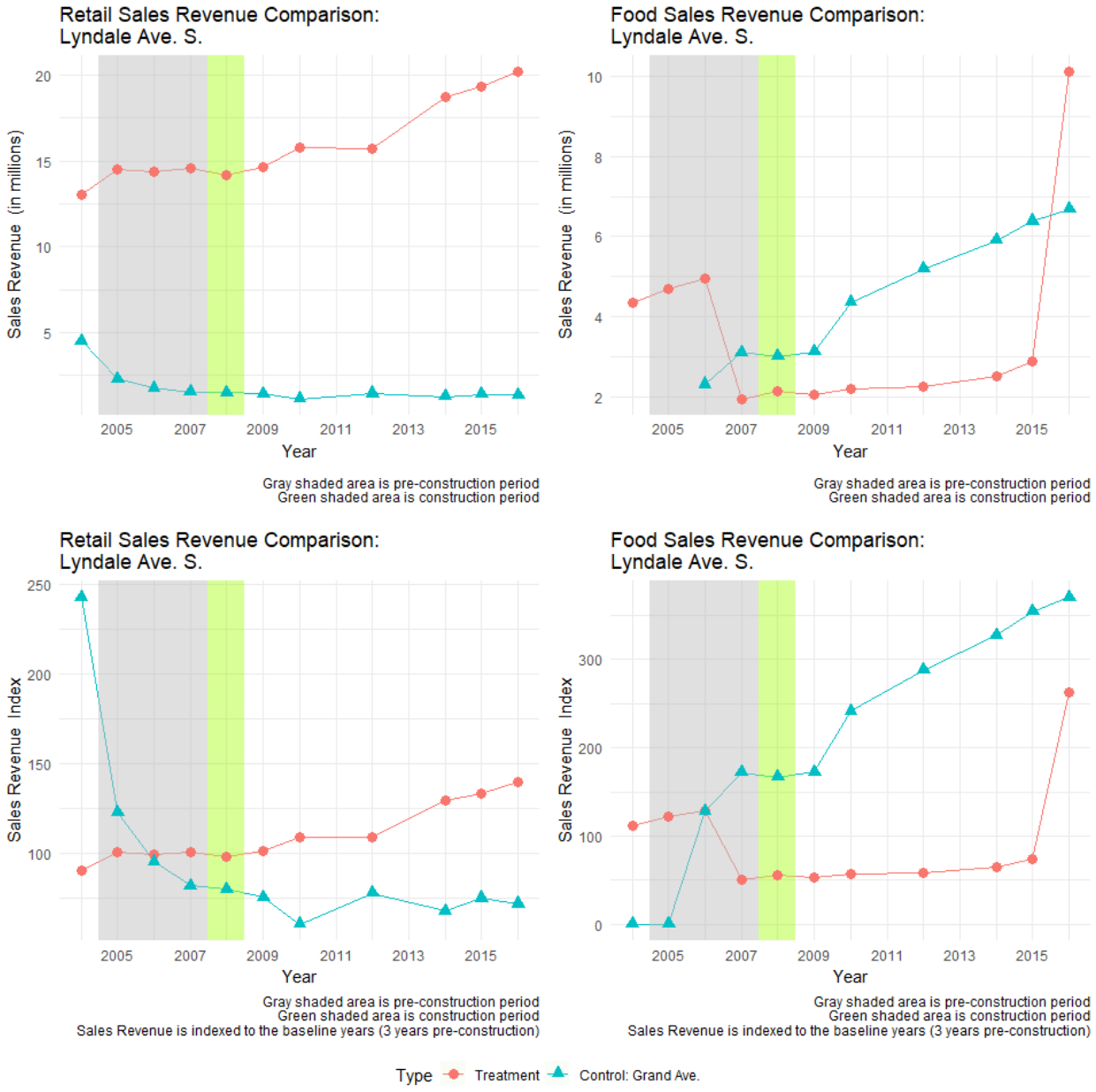

Figure 4-13. Lyndale Avenue Sales Revenue Comparison (Sales tax data)

4.4.1.1 QCEW

Though the baseline QCEW employment and wage numbers differ drastically between Lyndale Avenue South and Grand Avenue, they still offer some enlightenment as to overall patterns of growth. First, while Lyndale Avenue South starts from a much higher base employment, both corridors see some growth immediately pre-recession and consistent employment loss during the recession and recovery after. However, note that the post-recession recovery of employment on Lyndale Avenue South is more consistent compared to that of Grand Avenue, which shows small persistent decreases in its employment until nearly 2015.

Figure 4-14. Lyndale Avenue Employment and Total Wages Comparison (QCEW)

The indexed figures give us a better idea of the differences in patterns of growth between the two corridors. In particular, the growth trajectories for both wages and employment are similar in the treatment and control corridors, but Lyndale Avenue South is consistently less volatile and has a higher rate of growth. Again, note that this analysis does not show an immediately apparent relationship between the street improvement and wage or employment growth.

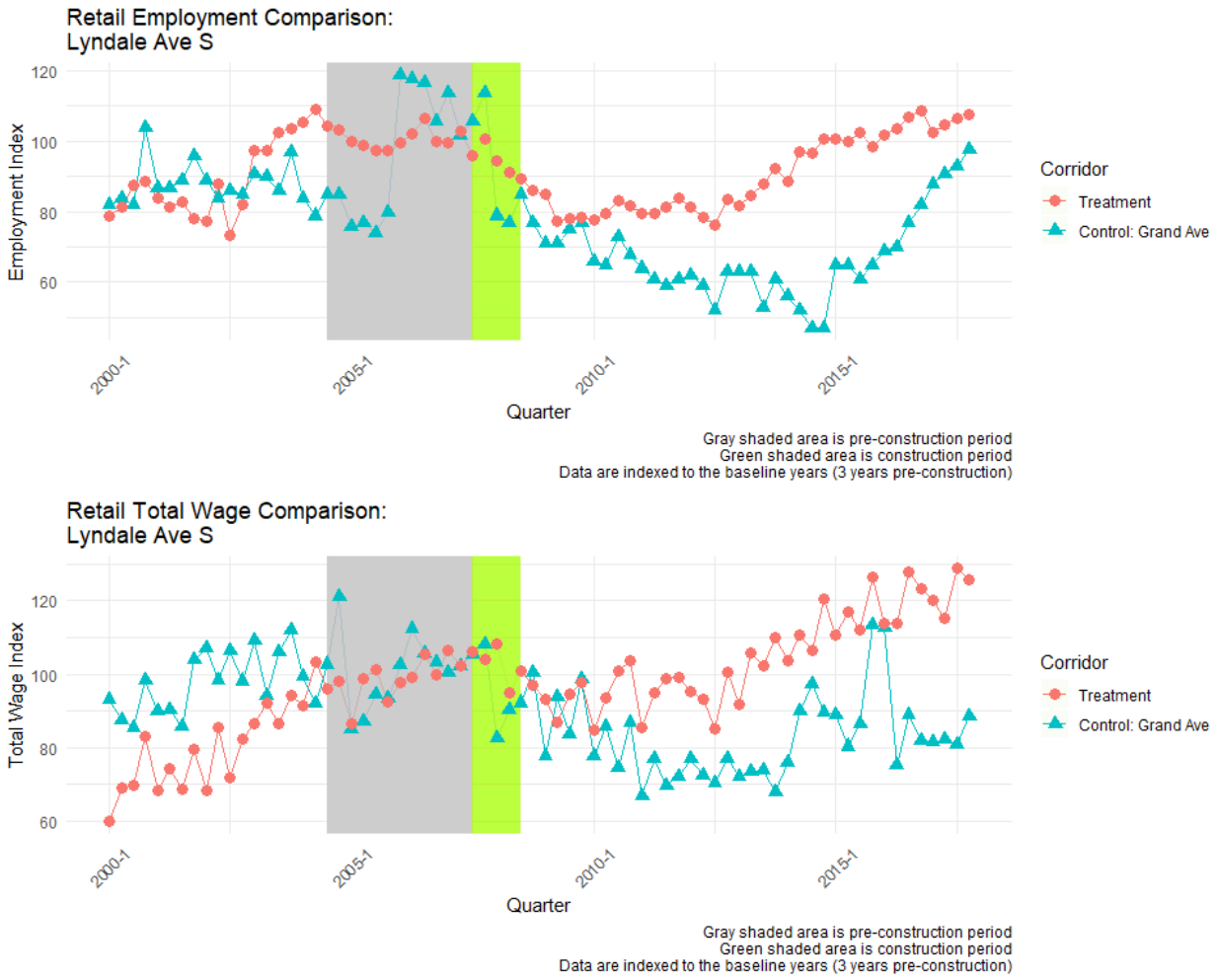

Figure 4-15. Lyndale Avenue Employment and Total Wages Comparison (QCEW)

Table 4-4. Lyndale Corridor Trend Analysis Summary Table

Area	Retail						Food					
	Baseline		Post-implementation				Baseline		Post-implementation			
	Base	Growth	1st Year	2nd Year	3rd Year	Avg.	Base	Growth	1st Year	2nd Year	3rd Year	Avg.
LEHD: [employment]												
Treatment	223	-2.18%	-11.21%	-0.51%	4.57%	-2.38%	125	-13.45%	-27.20%	0.00%	18.68%	-2.84%
Control: Grand	29	8.88%	-20.69%	-4.35%	40.91%	5.29%	24	-2.08%	141.67%	63.79%	58.95%	88.14%
Sales: [sales revenue, $]												
Treatment	14,481,508	0.19%	0.99%	7.74%	-0.23%	2.83%	3,864,204	-27.79%	-46.76%	6.58%	2.32%	-12.62%
Control: Grand	1,862,745	-18.24%	-24.77%	-19.99%	28.92%	-5.28%	2,705,890	34.06%	15.25%	39.69%	19.21%	24.72%
QCEW: [employment]												
Treatment	171	0.86%	7.46%	10.57%	4.92%	7.65%	-	-	-	-	-	-
Control: Grand	23	-8.70%	-13.04%	-15.83%	26.73%	-0.71%	-	-	-	-	-	-

[1] Baseline is defined as the average of previous three years before construction year;
[2] Pre-growth rate is defined as average of baseline annual growth rate;
[3] 1st year growth rate is defined as the growth rate of the year after construction compared to baseline.

The table above summarizes the detailed percentage changes of retail and food service economic indicators across three different data sources. There is an apparent drop in employment during the 2008-2010 recession period that coincides with the road diet construction period. The road diet boosted sales for retail sectors, and retail employment and wages.

4.4.2 DID Analysis

For Lyndale Avenue South, the DID analysis of LEHD data showed a statistically significant and negative effect of infrastructure installation on food employment and a non-significant result for retail employment.

The DID analysis of sales tax receipts on the street improvement corridor showed a non-significant effect of construction on restaurant sales tax receipts but a positive and significant effect on retail sales tax receipts. In this case, the model implies that the corridor construction was responsible for an additional $4 million in restaurant sales compared to the control corridor.

The QCEW DID results showed mixed results for Lyndale Avenue South. It showed a non-significant effect of the street improvement on Lyndale Avenue South on retail employment, but significantly positive effect on retail services wages. The models indicate a $226,026 total wage increase on Lyndale Avenue South compared to its control corridor after the street improvement.

4.4.3 ITS Analysis

The street improvement construction on Lyndale Avenue South was completed much earlier (in 2008), which provides for a longer time series of post-treatment data to validate our analysis. In this case, the LEHD data showed that there is a negative, statistically significant drop in the level of food employment for the corridor but a positive, significant slope. Again, when examining the aggregate employment trend graphs we see a clear drop in employment in 2009 and 2010 and a trend towards recovery to its pre-treatment level with a positive slope. The positive growth trend continues through 2015 but it is unclear if we will see a leveling off of new employment at this higher level or if the positive growth trend will persist.

In terms of sales tax returns, ITS analysis results on Lyndale South Avenue are similar to other corridors where there are statistically significant and negative effects on the *level* of receipts when comparing pre and post-construction periods, but also positive and significant changes in the *slope*, or rate of growth, of receipts. While the initial level drop is worrisome, robust growth across both restaurant and retail sales signals a potential positive effect of the infrastructure placement.

The ITS results of QCEW data are also mixed. In terms of employment, the model estimated a negative and significant level change (the pre_post term) and a non-significant slope change.. These QCEW results are somewhat different than the analysis results of LEHD and sales data, while all data sources showed similar drops in level (of employment or sales), the results do not provide definitive direction of the resulting slope change.

4.4.4 Key Results

- There is an apparent drop in employment during the 2008-2010 recession period that coincides with the road diet construction period on Lyndale Avenue South.
- Aside from the drop during the 2008-2010 recession, analysis of LEHD data shows that food service employment increased gradually after the road diet. This observation is confirmed by the ITS approach showing positive food service employment growth post-road diet. However, retail employment does not show any apparent patterns after the street improvement.
- The street improvement boosted sales for both the retail and food service sectors on Lyndale Avenue south. All three analytical approaches indicate a positive impact of the street improvement on retail sales, while impacts on restaurant sales are more mixed as only the ITS returns a positive and significant result (the DID and trend analyses do not show either positive or negative impacts).
- Given these results, we conclude that the road diet on Lyndale Avenue South greatly improved retail sales in the corridor and had a positive effect on business vitality.

4.5 North Second Street

4.5.1 Aggregated Trend Analysis

4.5.1.1 LEHD

Aggregated trend analysis on North Second Street point towards a probable impact of street improvement on employment trends, as the overall trend was quite negative prior to construction. Food employment growth is quite robust for the treatment corridor but its growth trend starts at the beginning of the construction period and continues afterwards. Both retail and food service employment on North Second Street appear to be growing at a rate greater than the city as a whole, and tracks the West Broadway Avenue control corridor closely.

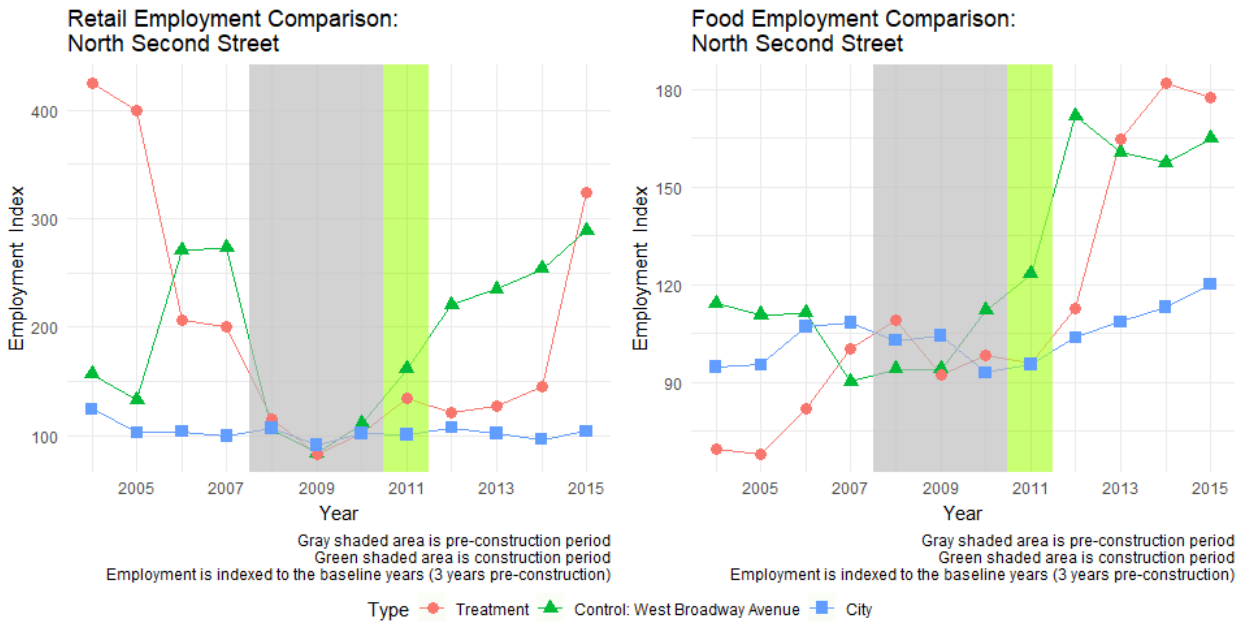

Figure 4-16. North Second Street Employment Comparison (LEHD)

4.5.1.1 Sales Tax

At first glance, North Second Street potential offers dramatic evidence of a positive effect of new infrastructure construction, but the extreme jump in sales tax receipts possibly signals external influences that may have affected sales along the corridor, such as the opening of multiple new establishments or one especially large establishment. The continued growth in retail sales after the initial large spike points to positive signs of overall business vitality along the street improvement corridor. This analysis did not include restaurant sales because the data indicated that no restaurant sales tax was collected on this street improvement corridor until 2014.

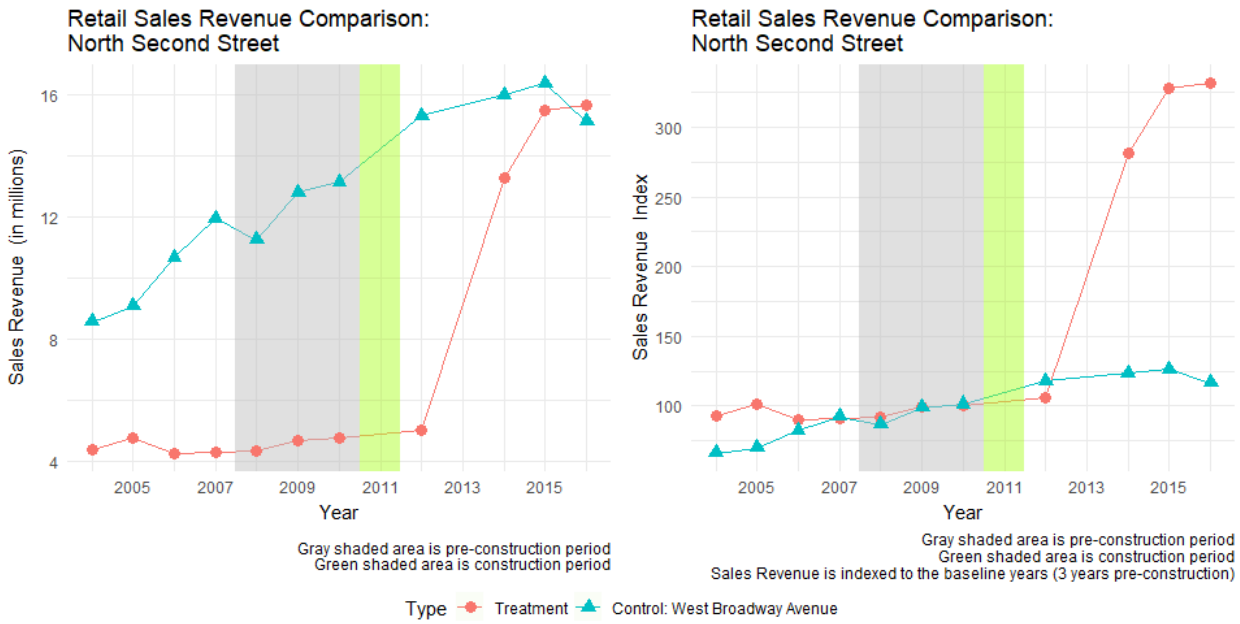

Figure 4-17. North Second Street Sales Revenue Comparison (Sales tax data)

The indexed plot highlights the immense rate of growth North Second Street has seen in retail sales since 2012, and the relatively static nature of retail activity on West Broadway Avenue. Again, it is unlikely that the new infrastructure is the principle cause of such a dramatic jump in sales, but consistent growth over time after the initial jump may be, in some part, connected to the new infrastructure.

4.5.1.1 QCEW

The QCEW employment and wage graphs show the general decline in business vitality of North Second Street compared to West Broadway Avenue over the last two decades, particularly prior to the street improvement construction period. After a high in the early 2000s, North Second Street has largely been in decline with a slight uptick starting 2012/2013, but it is still far below its peak. West Broadway Avenue, on the other hand, is defined by some dramatic drops in employment and quick recoveries, though its last major fall during the recession has met with only a mild recovery. Note that on North Second Street there is not an immediately apparent relationship between the construction period and employment or wages, although the construction also does not appear to result in any declines in employment or wages along the treatment corridor.

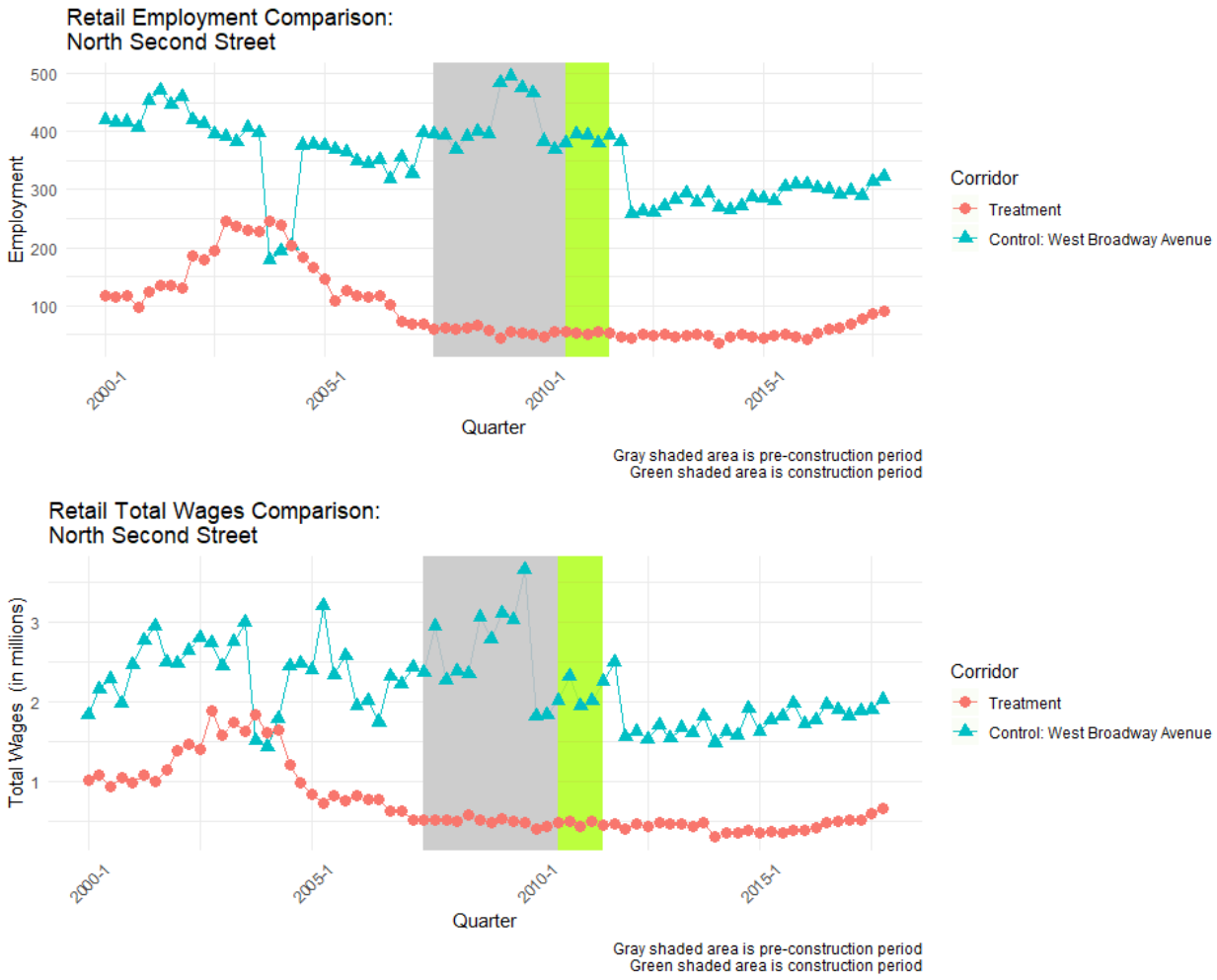

Figure 4-18. North Second Street Employment and Total Wages Comparison (QCEW)

The indexed figures reinforce what the above figures demonstrate but they do offer a clearer example of the mirrored growth trends between the treatment and control corridors starting around 2006/2007. Both corridors are only just now starting to grow beyond their 2011 baseline values with North Second Street showing a greater growth rate than Wset Broadway Avenue post-2015. This again reinforces the finding that the street improvement construction did not appear to contribute to any changes in the employment and wage trajectories on North Second Street.

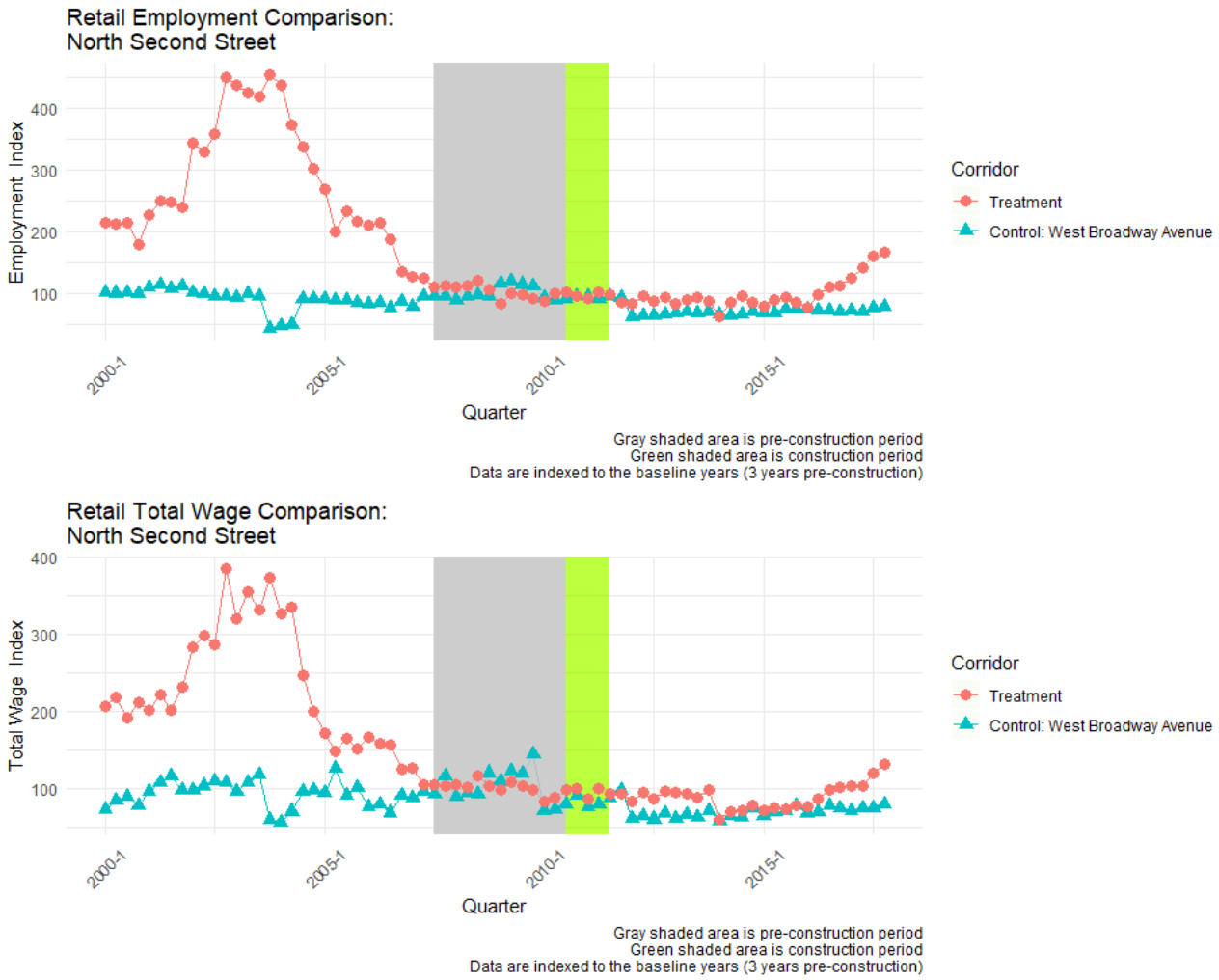

Figure 4-19. North Second Street Indexed Employment and Total Wages Comparison (QCEW)

Table 4-5. North Second 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	117	-2.47%	20.51%	5.67%	13.42%	13.20%	385	-4.49%	12.73%	46.08%	10.57%	23.13%
Control: Broadway	104	6.00%	120.19%	6.55%	7.79%	44.84%	233	9.59%	71.67%	-6.50%	-1.87%	21.10%
Sales: (sales revenue, $)												
Treatment	4,580,133	4.84%	8.78%	166.13%	16.60%	63.84%	-	-	-	-	-	-
Control: Broadway	12,387,933	8.32%	23.42%	4.48%	2.53%	10.14%	11,050,000	-1.96%	8.91%	-10.55	27.27	8.55%
QCEW: (employment)												
Treatment	54	-6.97%	-10.03%	-1.20%	-7.47%	-6.23%	-	-	-	-	-	-
Control: Broadway	417	1.60%	-36.97%	9.29%	-4.96%	-10.88%	-	-	-	-	-	-

[1] Baseline is defined as the average of previous three years before construction year;
[2] Pre-growth rate is defined as average of baseline annual growth rate;
[3] 1st year growth rate is defined as the growth rate of the year after construction compared to baseline.

The table above summarizes the detailed percentage changes of retail and food services economic indicators across three different data sources. LEHD data shows erratic retail employment growth on North Second Street and a peak employment level in 2015. However, QCEW data only shows a slight increase two years after the street improvement. There is a dramatic jump in retail sales right after bike lane installation, indicating a positive impact of bike lanes on retail sales.

4.5.2 DID Analysis

Our DID estimation using LEHD data shows a positive and significant effect of treatment responsible for approximately 247 additional food service jobs while retail has a negative but non-significant effect.

Due to missing data we only ran a DID estimation for the retail sales tax receipts, and the estimated DID term for North Second Street is negative but non-significant. This indicates that there is not a causal relationship between the change in retail sales tax receipts and new infrastructure placement compared to the control corridor.

The DID analysis of QCEW employment data showed that a statistically significant result that the construction of the new cycling infrastructure on North Second Street contributed to the corridor having 38 fewer retail jobs when compared with its counterpart. However, this is countered by the non-significant results of the DID wages model. There may have

been an industrial shift from retail to food services or changes in the types of establishments along North Second Street that contributed to these analytical results.

4.5.3 ITS Analysis

ITS analysis of LEHD data on North Second Street also presented mixed results. The corridor has a large, negative and significant drop in retail employment level, as well as a borderline significant drop in food employment. But the corridor also has a significant and positive slope showing a vigorous rate of job growth post-construction.

The mixed results are also reflected when looking at the corridor's sales tax receipts. Our ITS models show that there is a large, negative and significant drop in the level of sales revenues, but a positive, and significant, change in the growth rate of sales revenues post-construction. Assuming that this rate of growth persists, the street improvement corridor should ultimately see more sales post-construction. However, it is difficult to make a definitive statement on the causal nature of the relationship between the construction and sales revenue at this point. The QCEW ITS wages model also show that the slope change is significant and positive, while the level change term is significant and negative.

Ultimately, the ITS analyses on North Second Street yielded mixed results, but generally showed that the new infrastructure resulted in positive growth patterns.

4.5.4 Key Results

- LEHD data shows erratic retail employment growth on North Second Street and a peak employment level in 2015. However, QCEW data only shows a slight increase two years after the street improvement. Given the risks of applying LEHD data in smaller geographic areas, the QCEW data trend is likely more reliable. Ultimately, none of the three approaches show a causal impact of bike lane construction on retail employment.
- There is a positive and significant impact of bike lane installation on food employment that is supported by all three approaches using LEHD data. But because the corridors intersect, the DID estimates may be potentially biased due to possible spillover effects.
- There is a dramatic jump in retail sales right after bike lane installation, indicating a positive impact of bike lanes on retail sales. However, the large jump might also be related to other one-time changes, such as a large new store opening, which needs further investigation.
- Further analysis is required to draw a conclusion about the impact of the bike lane installations on business vitality on North Second Street.

5. Conclusion

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

- The bike lane on Franklin Avenue triggered a significant employment increase in the food services industry approximately two years after installation.
- On Central Avenue, we found a significant positive impact on restaurant sales on Central Avenue following bike lane construction.
- The road diet on Lyndale Avenue South greatly improved retail sales in the corridor.

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. In Minneapolis, sales tax data may only capture parts of economic activities that are subject to sales tax, because sales of clothing and unprepared food are tax exempt; and QCEW data for Minneapolis is limited to the retail sector (excluding food and 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 Corridor Comparisons

T-statistics of Corridor Comparison test (numbers in parentheses indicate p-value)

Corridor	Job per block		Business job share		Pre-construction growth rate	
	Retail	Food	Metric 1	Metric 2	Retail	Food
Riverside						
Cedar	0.451 (0.658)	-0.404 (0.694)	0.574 (0.576)	0.673 (0.515)	1.144 (0.297)	0.855 (0.454)
Franklin						
Franklin (control)	1.891 (0.077)	0.614 (0.544)	0.759 (0.452)	-0.028 (0.977)	8.992 (0.000)	22.048 (0.000)
Central						
University	0.319 (0.751)	-2.241 (0.030)	-1.752 (0.087)	-1.572 (0.124)	-0.295 (0.773)	-0.016 (0.987)
Lyndale						
Grand	1.530 (0.136)	1.333 (0.191)	-0.026 (0.979)	0.301 (0.764)	1.116 (0.319)	-0.674 (0.539)
North Second						
West Broadway	-0.524 (0.601)	0.618 (0.538)	-3.292 (0.002)	-3.667 (0.000)	-0.966 (0.357)	0.560 (0.586)

Note: Business job share Metric 1 represents the number of business employment divided by the sum of other services industry employment such as professional/scientific services, public administration and educational services; alternatively, Metric 2 is calculated using a smaller subset of service employment (including professional/scientific services, administrative/waste management services and arts/accommodation services).

7.2 LEHD

7.2.1 Riverside Avenue

Riverside Corridor Difference-in-Difference Estimates

	Dependent variable:		
	CNS07	CNS18	business
	Retail Emp.	Accomodations Emp.	'Business' Emp.
	(1)	(2)	(3)
Typeimprovement	152.000***	42.000*	194.000***
	(38.980)	(20.441)	(56.464)
prepost	12.333	36.000*	48.333
	(38.980)	(20.441)	(56.464)
Typeimprovement:prepost	289.833***	33.500	323.333***
	(55.125)	(28.908)	(79.852)
Constant	110.833***	78.000***	188.833***
	(27.563)	(14.454)	(39.926)
Observations	24	24	24
R^2	0.898	0.609	0.861
Adjusted R^2	0.883	0.551	0.840
Residual Std. Error (df = 20)	67.515	35.404	97.799
F Statistic (df = 3; 20)	58.746***	10.395***	41.138***
Note:			*p<0.1; **p<0.05;** p<0.01*

Interrupted Time Series- Riverside Ave.

	Dependent variable:		
	CNS07	CNS18	business
	Retail Emp.	Accomodations Emp.	'Business' Emp.
	(1)	(2)	(3)
ts_year	35.571***	16.457*	52.029***
	(10.262)	(7.566)	(14.746)
prepost	-91.762	-109.314	-201.076
	(106.813)	(78.749)	(153.484)
ts_year:prepost	19.000	8.429	27.429
	(14.513)	(10.700)	(20.854)
Constant	138.333***	62.400*	200.733***
	(39.966)	(29.465)	(57.428)
Observations	12	12	12
R^2	0.959	0.790	0.949
Adjusted R^2	0.944	0.711	0.931
Residual Std. Error (df = 8)	42.930	31.651	61.688
F Statistic (df = 3; 8)	62.973***	10.005***	50.128***
Note:			*p<0.1; **p<0.05;** p<0.01*

7.2.2 Franklin Avenue

Franklin Ave. Corridor Difference-in-Difference Estimates

	Dependent variable:		
	CNS07	CNS18	business
	Retail Emp.	Accomodations Emp.	'Business' Emp.
	(1)	(2)	(3)
Typeimprovement	139.250***	31.500**	170.750***
	(17.327)	(12.501)	(23.910)
prepost	22.875	4.500	27.375
	(21.221)	(15.311)	(29.283)
Typeimprovement:prepost	120.750***	22.500	143.250***
	(30.011)	(21.652)	(41.413)
Constant	27.375**	105.500***	132.875***
	(12.252)	(8.840)	(16.907)
Observations	24	24	24
R^2	0.912	0.471	0.889
Adjusted R^2	0.899	0.391	0.872
Residual Std. Error (df = 20)	34.653	25.002	47.820
F Statistic (df = 3; 20)	69.318***	5.932***	53.364***
Note:			*p<0.1;* ***p<0.05;*** p<0.01

Interrupted Time Series- Franklin Ave.

	Dependent variable:		
	CNS07	CNS18	business
	Retail Emp.	Accommodations Emp.	'Business' Emp.
	(1)	(2)	(3)
ts_year	14.393**	-0.286	14.107
	(6.040)	(3.536)	(8.005)
prepost	14.143	-257.786**	-243.643
	(187.355)	(109.685)	(248.285)
ts_year:prepost	4.107	27.286**	31.393
	(18.519)	(10.842)	(24.542)
Constant	101.857**	138.286***	240.143***
	(30.502)	(17.857)	(40.421)
Observations	12	12	12
R^2	0.842	0.571	0.817
Adjusted R^2	0.783	0.410	0.749
Residual Std. Error (df = 8)	39.145	22.917	51.876
F Statistic (df = 3; 8)	14.231***	3.549*	11.934***
Note:			*p<0.1;* ***p<0.05;*** p<0.01

7.2.3 Central Avenue

Central Ave. Corridor Difference-in-Difference Estimates

	Dependent variable:		
	CNS07	CNS18	business
	Retail Emp.	Accomodations Emp.	'Business' Emp.
	(1)	(2)	(3)
Typeimprovement	-28.111**	-291.111***	-319.222***
	(11.756)	(20.594)	(28.135)
prepost	71.889***	222.444***	294.333***
	(16.625)	(29.125)	(39.789)
Typeimprovement:prepost	-14.556	-202.889***	-217.444***
	(23.511)	(41.189)	(56.271)
Constant	202.444***	387.889***	590.333***
	(8.312)	(14.562)	(19.895)
Observations	24	24	24
R^2	0.668	0.955	0.936
Adjusted R^2	0.619	0.948	0.927
Residual Std. Error (df = 20)	24.937	43.687	59.684
F Statistic (df = 3; 20)	13.439***	142.041***	97.844***
Note:			*p<0.1; **p<0.05;** p<0.01*

Interrupted Time Series- Central Ave.

	Dependent variable:		
	CNS07	CNS18	business
	Retail Emp.	Accommodations Emp.	'Business' Emp.
	(1)	(2)	(3)
ts_year	6.583***	0.833	7.417***
	(1.708)	(1.531)	(2.145)
prepost	-267.250**	-207.278*	-474.528***
	(103.616)	(92.874)	(130.136)
ts_year:prepost	25.917**	20.167**	46.083***
	(9.508)	(8.522)	(11.941)
Constant	141.417***	92.611***	234.028***
	(9.610)	(8.613)	(12.069)
Observations	12	12	12
R^2	0.896	0.613	0.910
Adjusted R^2	0.858	0.468	0.876
Residual Std. Error (df = 8)	13.228	11.856	16.613
F Statistic (df = 3; 8)	23.069***	4.231**	26.965***
Note:			*p<0.1; **p<0.05;** p<0.01*

7.2.4 Lyndale Avenue South

Lyndale Ave. Corridor Difference-in-Difference Estimates

	Dependent variable:		
	CNS07	CNS18	business
	Retail Emp.	Accomodations Emp.	'Business' Emp.
	(1)	(2)	(3)
Typeimprovement	173.667***	78.333***	252.000***
	(12.747)	(11.934)	(18.859)
prepost	-0.667	108.667***	108.000***
	(12.747)	(11.934)	(18.859)
Typeimprovement:prepost	-1.333	-109.333***	-110.667***
	(18.027)	(16.877)	(26.671)
Constant	26.833***	35.833***	62.667***
	(9.013)	(8.438)	(13.335)
Observations	24	24	24
R^2	0.949	0.819	0.926
Adjusted R^2	0.941	0.792	0.915
Residual Std. Error (df = 20)	22.078	20.670	32.665
F Statistic (df = 3; 20)	122.812***	30.262***	83.436***
Note:			*p<0.1; **p<0.05;** p<0.01*

Interrupted Time Series- Lyndale Ave.

	Dependent variable:		
	CNS07	CNS18	business
	Retail Emp.	Accommodations Emp.	'Business' Emp.
	(1)	(2)	(3)
ts_year	8.943	-7.000	1.943
	(7.589)	(3.794)	(10.400)
prepost	11.114	-100.895**	-89.781
	(78.990)	(39.485)	(108.242)
ts_year:prepost	-7.029	14.971**	7.943
	(10.733)	(5.365)	(14.707)
Constant	169.200***	138.667***	307.867***
	(29.555)	(14.774)	(40.500)
Observations	12	12	12
R^2	0.155	0.494	0.106
Adjusted R^2	-0.162	0.305	-0.229
Residual Std. Error (df = 8)	31.748	15.870	43.504
F Statistic (df = 3; 8)	0.488	2.608	0.317
Note:			*p<0.1; **p<0.05;** p<0.01*

7.2.5 North 2nd Street

North Second St.Corridor Difference-in-Difference Estimates

	Dependent variable:		
	CNS07	CNS18	business
	Retail Emp.	Accomodations Emp.	'Business' Emp.
	(1)	(2)	(3)
Typeimprovement	75.375	97.000***	172.375***
	(56.039)	(30.500)	(56.304)
prepost	91.250	133.875***	225.125***
	(68.633)	(37.355)	(68.958)
Typeimprovement:prepost	-125.125	135.000**	9.875
	(97.062)	(52.827)	(97.522)
Constant	167.750***	247.375***	415.125***
	(39.625)	(21.567)	(39.813)
Observations	24	24	24
R^2	0.113	0.829	0.648
Adjusted R^2	-0.020	0.804	0.596
Residual Std. Error (df = 20)	112.077	61.000	112.609
F Statistic (df = 3; 20)	0.851	32.390***	12.291***
Note:			*p<0.1;* ***p<0.05;*** p<0.01

Interrupted Time Series- North 2nd Ave.

	Dependent variable:		
	CNS07	CNS18	business
	Retail Emp.	Accommodations Emp.	'Business' Emp.
	(1)	(2)	(3)
ts_year	-55.298***	17.345*	-37.952***
	(12.616)	(8.172)	(8.785)
prepost	-1,050.264**	-510.921*	-1,561.186***
	(391.312)	(253.463)	(272.493)
ts_year:prepost	128.398**	64.355**	192.752***
	(38.679)	(25.054)	(26.935)
Constant	491.964***	266.321***	758.286***
	(63.706)	(41.264)	(44.362)
Observations	12	12	12
R^2	0.747	0.914	0.927
Adjusted R^2	0.653	0.882	0.899
Residual Std. Error (df = 8)	81.759	52.958	56.934
F Statistic (df = 3; 8)	7.889***	28.382***	33.686***
Note:			*p<0.1;* ***p<0.05;*** p<0.01

7.3 Sales Tax

7.3.1 Riverside Avenue

Riverside Ave. Sales Tax Difference-in-Difference Estimates

	Dependent variable:	
	Restaurant	Retail
	Restaurant Sales	Retail Sales
	(1)	(2)
TypeImprovement	321,810.100	-950,844.300***
	(766,584.800)	(167,910.400)
pre_post	2,857,108.000***	1,698,041.000***
	(733,949.100)	(160,762.000)
TypeImprovement:pre_post	-1,350,468.000	-1,754,462.000***
	(1,037,961.000)	(227,351.800)
Constant	6,629,566.000***	5,376,522.000***
	(542,057.300)	(118,730.600)
Observations	22	22
R^2	0.526	0.956
Adjusted R^2	0.448	0.949
Residual Std. Error (df = 18)	1,212,077.000	265,489.600
F Statistic (df = 3; 18)	6.671***	131.902***
Note:		*p<0.1;* ***p<0.05;*** p<0.01

Riverside Ave. Sales Tax ITS Estimates

	Dependent variable:	
	Restaurant	Retail
	Restaurant Sales	Retail Sales
	(1)	(2)
ts_year	260,711.600***	-139,625.600**
	(62,588.900)	(52,380.320)
pre_post	-1,721,165.000***	92,509.850
	(377,737.000)	(316,126.100)
ts_year:pre_post	154,109.700*	80,886.790
	(70,095.020)	(58,662.150)
Constant	6,169,241.000***	4,844,555.000***
	(207,583.900)	(173,725.900)
Observations	11	11
R^2	0.980	0.639
Adjusted R^2	0.972	0.484
Residual Std. Error (df = 7)	197,923.500	165,641.100
F Statistic (df = 3; 7)	116.055***	4.123*
Note:		*p<0.1;* ***p<0.05;*** p<0.01

7.3.2 Franklin Avenue

Franklin Ave. Sales Tax ITS Estimates

	Dependent variable:	
	Restaurant	Retail
	Restaurant Sales	Retail Sales
	(1)	(2)
ts_year	778,760.300**	1,143,750.000**
	(320,126.000)	(477,430.900)
pre_post	15,338,651.000*	6,955,883.000
	(6,653,694.000)	(9,923,216.000)
ts_year:pre_post	-2,040,003.000**	-1,058,863.000
	(656,063.100)	(978,442.300)
Constant	3,830,741.000**	2,851,896.000
	(1,431,647.000)	(2,135,136.000)
Observations	11	11
R^2	0.670	0.593
Adjusted R^2	0.528	0.418
Residual Std. Error (df = 7)	1,693,948.000	2,526,327.000
F Statistic (df = 3; 7)	4.732**	3.396*
Note:		*p<0.1;* ***p<0.05;*** p<0.01

7.3.3 Central Avenue

Central Ave. Sales Tax Difference-in-Difference Estimates

	Dependent variable:	
	Restaurant	Retail
	Restaurant Sales	Retail Sales
	(1)	(2)
TypeImprovement	-10,619,800.000***	-18,768,572.000***
	(649,782.100)	(838,441.000)
pre_post	9,179,680.000***	-2,866,845.000***
	(761,937.100)	(983,159.300)
TypeImprovement:pre_post	-5,752,489.000***	7,168,875.000***
	(1,077,542.000)	(1,390,397.000)
Constant	13,453,798.000***	30,588,644.000***
	(459,465.300)	(592,867.400)
Observations	22	22
R^2	0.977	0.971
Adjusted R^2	0.973	0.967
Residual Std. Error (df = 18)	1,215,631.000	1,568,580.000
F Statistic (df = 3; 18)	255.593***	203.843***
Note:		*p<0.1; **p<0.05;** p<0.01*

Central Ave. Sales Tax ITS Estimates

	Dependent variable:	
	Restaurant	Retail
	Restaurant Sales	Retail Sales
	(1)	(2)
ts_year	-81,086.390**	791,191.500***
	(24,587.040)	(212,880.600)
pre_post	-10,816,427.000***	1,015,786.000
	(511,032.100)	(4,424,641.000)
ts_year:pre_post	1,318,355.000***	-217,768.500
	(50,388.440)	(436,275.500)
Constant	3,158,344.000***	8,655,305.000***
	(109,956.600)	(952,031.200)
Observations	11	11
R^2	0.997	0.884
Adjusted R^2	0.996	0.834
Residual Std. Error (df = 7)	130,102.400	1,126,459.000
F Statistic (df = 3; 7)	856.183***	17.736***
Note:		*p<0.1; **p<0.05;** p<0.01*

7.3.4 Lyndale Avenue South

Lyndale Ave. S. Sales Tax Difference-in-Difference Estimates

	Dependent variable:	
	Restaurant	Retail
	Restaurant Sales	Retail Sales
	(1)	(2)
TypeImprovement	809,529.200	11,811,766.000***
	(1,510,326.000)	(877,023.200)
pre_post	2,470,209.000	-993,027.000
	(1,462,367.000)	(839,685.800)
TypeImprovement:pre_post	-2,420,510.000	4,251,122.000***
	(1,925,296.000)	(1,187,495.000)
Constant	2,805,993.000**	2,319,934.000***
	(1,194,018.000)	(620,149.100)
Observations	20	22
R^2	0.184	0.970
Adjusted R^2	0.031	0.965
Residual Std. Error	2,068,099.000 (df = 16)	1,386,695.000 (df = 18)
F Statistic	1.205 (df = 3; 16)	195.854*** (df = 3; 18)
Note:		*p<0.1;* ***p<0.05;*** p<0.01

Lyndale Ave. S. Sales Tax ITS Estimates

	Dependent variable:	
	Restaurant	Retail
	Restaurant Sales	Retail Sales
	(1)	(2)
ts_year	-715,005.200	221,626.100
	(682,128.400)	(196,411.800)
pre_post	-9,198,013.000*	-3,762,778.000**
	(4,116,787.000)	(1,185,386.000)
ts_year:pre_post	1,449,767.000*	573,451.600**
	(763,934.300)	(219,967.000)
Constant	5,760,538.000**	13,466,821.000***
	(2,262,364.000)	(651,424.400)
Observations	11	11
R^2	0.447	0.953
Adjusted R^2	0.210	0.932
Residual Std. Error (df = 7)	2,157,079.000	621,108.800
F Statistic (df = 3; 7)	1.888	46.924***
Note:		*p<0.1;* ***p<0.05;*** p<0.01

7.3.5 North 2nd Street

North 2nd Sales Tax Difference-in-Difference Estimates

	Dependent variable:
	Retail
	Retail Sales
TypeImprovement	-6,566,712.000***
	(1,231,397.000)
pre_post	4,633,695.000***
	(1,443,941.000)
TypeImprovement:pre_post	3,213,779.000
	(2,042,041.000)
Constant	11,055,631.000***
	(870,729.400)
Observations	22
R^2	0.796
Adjusted R^2	0.761
Residual Std. Error	2,303,733.000 (df = 18)
F Statistic	23.344*** (df = 3; 18)
Note:	*p<0.1;* ***p<0.05;*** p<0.01

North 2nd Sales Tax ITS Estimates

	Dependent variable:
	Retail
	Retail Sales
ts_year	35,137.710
	(197,114.800)
pre_post	-23,442,344.000***
	(4,096,955.000)
ts_year:pre_post	2,758,673.000***
	(403,965.200)
Constant	4,348,369.000***
	(881,524.300)
Observations	11
R^2	0.967
Adjusted R^2	0.953
Residual Std. Error	1,043,034.000 (df = 7)
F Statistic	68.966*** (df = 3; 7)
Note:	*p<0.1;* ***p<0.05;*** p<0.01

7.4 QCEW

7.4.1 Riverside Avenue

Riverside Avenue QCEW Difference-in-Difference Estimates

	Dependent variable:	
	avg_emp	total_wages
	Average Employment	Total Wages
	(1)	(2)
street_typeControl: Cedar Ave	35.963***	-673,883.400***
	(10.501)	(192,784.100)
pre_post	110.456***	2,506,585.000***
	(10.824)	(198,717.300)
street_typeControl: Cedar Ave:pre_post	-104.567***	-2,280,422.000***
	(15.081)	(276,865.100)
Constant	93.815***	1,132,319.000***
	(7.425)	(136,319.000)
Observations	140	140
R^2	0.441	0.701
Adjusted R^2	0.429	0.694
Residual Std. Error (df = 136)	44.551	817,913.700
F Statistic (df = 3; 136)	35.821***	106.274***
Note:		*p<0.1;* ***p<0.05;*** p<0.01

Riverside Avenue QCEW ITS Estimates

	Dependent variable:	
	avg_emp	tot_wages
	Average Employment	Total Wages
	(1)	(2)
ts_year	26.301***	1,644,383.000***
	(4.372)	(401,008.800)
pre_post	145.201**	8,835,513.000
	(61.565)	(5,647,442.000)
ts_year:pre_post	-20.647***	-1,171,224.000*
	(6.182)	(567,112.100)
Constant	-11.391	-2,048,257.000
	(20.813)	(1,909,184.000)
Observations	18	18
R^2	0.863	0.785
Adjusted R^2	0.834	0.739
Residual Std. Error (df = 14)	33.862	3,106,201.000
F Statistic (df = 3; 14)	29.476***	17.062***
Note:		*p<0.1;* ***p<0.05;*** p<0.01

7.4.2 Franklin Avenue

Franklin Ave ITS Estimates

	Dependent variable:	
	avg_emp	tot_wages
	Average Employment	Total Wages
	(1)	(2)
ts_year	10.893***	343,091.200***
	(1.860)	(51,114.950)
pre_post	61.063	-1,728,766.000
	(53.283)	(1,464,347.000)
ts_year:pre_post	-1.307	278,530.000**
	(4.129)	(113,477.200)
Constant	108.110***	1,560,070.000***
	(11.003)	(302,400.100)
Observations	18	18
R^2	0.950	0.972
Adjusted R^2	0.939	0.967
Residual Std. Error (df = 14)	19.507	536,098.100
F Statistic (df = 3; 14)	87.982***	164.758***
Note:		*p<0.1;* ***p<0.05;*** p<0.01

7.4.3 Central Avenue

Central Ave. QCEW Difference-in-Difference Estimates

	Dependent variable:	
	avg_emp	total_wages
	Average Employment	Total Wages
	(1)	(2)
pre_post	61.785***	530,745.000***
	(12.262)	(90,360.640)
street_typeControl: University Ave	-18.437*	59,994.460
	(10.012)	(73,779.150)
pre_post:street_typeControl: University Ave	-15.368	-226,026.800*
	(17.341)	(127,789.200)
Constant	189.424***	1,069,647.000***
	(7.079)	(52,169.740)
Observations	144	144
R^2	0.255	0.247
Adjusted R^2	0.239	0.231
Residual Std. Error (df = 140)	49.047	361,442.600
F Statistic (df = 3; 140)	16.009***	15.312***
Note:		*p<0.1;* ***p<0.05;*** p<0.01

Central Ave QCEW ITS Estimates

	Dependent variable:	
	avg_emp	tot_wages
	Average Employment	Total Wages
	(1)	(2)
ts_year	8.968**	212,501.100**
	(3.442)	(89,189.410)
pre_post	-339.805**	-11,827,929.000***
	(145.390)	(3,767,176.000)
ts_year:pre_post	22.129*	830,234.400***
	(10.424)	(270,104.500)
Constant	140.098***	3,109,830.000***
	(22.352)	(579,159.100)
Observations	18	18
R^2	0.648	0.732
Adjusted R^2	0.573	0.675
Residual Std. Error (df = 14)	41.162	1,066,550.000
F Statistic (df = 3; 14)	8.596***	12.751***
Note:		*p<0.1;* ***p<0.05;*** p<0.01

7.4.4 Lyndale Avenue South

Lyndale Ave. S. QCEW Difference-in-Difference Estimates

	Dependent variable:	
	avg_emp	total_wages
	Average Employment	Total Wages
	(1)	(2)
pre_post	-7.367*	180,924.300***
	(3.778)	(24,052.830)
street_typeControl: Grand Ave	-168.552***	-844,741.300***
	(3.982)	(25,353.910)
pre_post:street_typeControl: Grand Ave	-0.656	-201,293.000***
	(5.343)	(34,015.830)
Constant	199.333***	969,520.300***
	(2.816)	(17,927.920)
Observations	144	144
R^2	0.967	0.959
Adjusted R^2	0.966	0.958
Residual Std. Error (df = 140)	15.929	101,415.600
F Statistic (df = 3; 140)	1,352.184***	1,086.692***
Note:		*p<0.1; **p<0.05;** p<0.01*

Lyndale Ave. S. QCEW ITS Estimates

	Dependent variable:	
	avg_emp	tot_wages
	Average Employment	Total Wages
	(1)	(2)
ts_year	6.875***	229,572.900***
	(2.208)	(34,195.650)
pre_post	-58.620**	-287,754.400
	(22.214)	(344,079.300)
ts_year:pre_post	-0.850	-84,376.340*
	(2.712)	(42,007.670)
Constant	175.271***	3,074,576.000***
	(9.235)	(143,050.700)
Observations	18	18
R^2	0.646	0.901
Adjusted R^2	0.570	0.880
Residual Std. Error (df = 14)	14.307	221,613.100
F Statistic (df = 3; 14)	8.503***	42.627***
Note:		*p<0.1; **p<0.05;** p<0.01*

7.4.5 North 2nd Street

North 2nd Ave QCEW Difference in Difference Estimates

	Dependent variable:	
	avg_emp	total_wages
	Average Employment	Total Wages
	(1)	(2)
pre_post	-83.500***	-581,036.400***
	(13.425)	(91,569.920)
street_typeControl: Broadway Ave	239.500***	1,359,094.000***
	(13.425)	(91,569.920)
pre_post:street_typeControl: Broadway Ave	38.120**	167,260.800
	(18.986)	(129,499.400)
Constant	136.380***	1,028,028.000***
	(9.493)	(64,749.710)
Observations	144	144
R^2	0.850	0.799
Adjusted R^2	0.847	0.795
Residual Std. Error (df = 140)	56.957	388,498.300
F Statistic (df = 3; 140)	264.001***	185.716***
Note:		*p<0.1;* ***p<0.05;*** p<0.01

North 2nd St. QCEW ITS Estimates

	Dependent variable:	
	avg_emp	tot_wages
	Average Employment	Total Wages
	(1)	(2)
ts_year	-11.896**	-400,416.700***
	(5.222)	(129,981.000)
pre_post	-155.386*	-3,881,193.000*
	(73.540)	(1,830,534.000)
ts_year:pre_post	13.765*	396,984.500**
	(7.385)	(183,821.000)
Constant	183.963***	5,713,780.000***
	(24.861)	(618,833.600)
Observations	18	18
R^2	0.636	0.705
Adjusted R^2	0.558	0.642
Residual Std. Error (df = 14)	40.449	1,006,829.000
F Statistic (df = 3; 14)	8.165***	11.156***
Note:		*p<0.1;* ***p<0.05;*** p<0.01