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Jenny H. Liu

Portland State University, jenny.liu@pdx.edu

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Economic and Business Outcomes of Bicycle and Pedestrian Improvements

NITC Webinar 10-06-2020



Jenny H. Liu, Ph.D.

Associate Professor, School of Urban Studies & Planning
Director, Center for Urban Studies



Portland State
UNIVERSITY

Impact of Bike Facilities on Residential Property Prices –

- **Liu, J.H.** 2016. Portland Green Loop Economic Analysis. Northwest Economic Research Center (NERC) Report in collaboration with the City of Portland Bureau of Planning and Sustainability (BPS). ([link](#))
- **Liu, J.H.** and Shi, W.¹ 2017. Impact of Bike Facilities on Residential Property Prices. *Transportation Research Record: Journal of the Transportation Research Board*, 2662, 50-58. ([link](#))



Portland **GREEN LOOP**
Economic Analysis

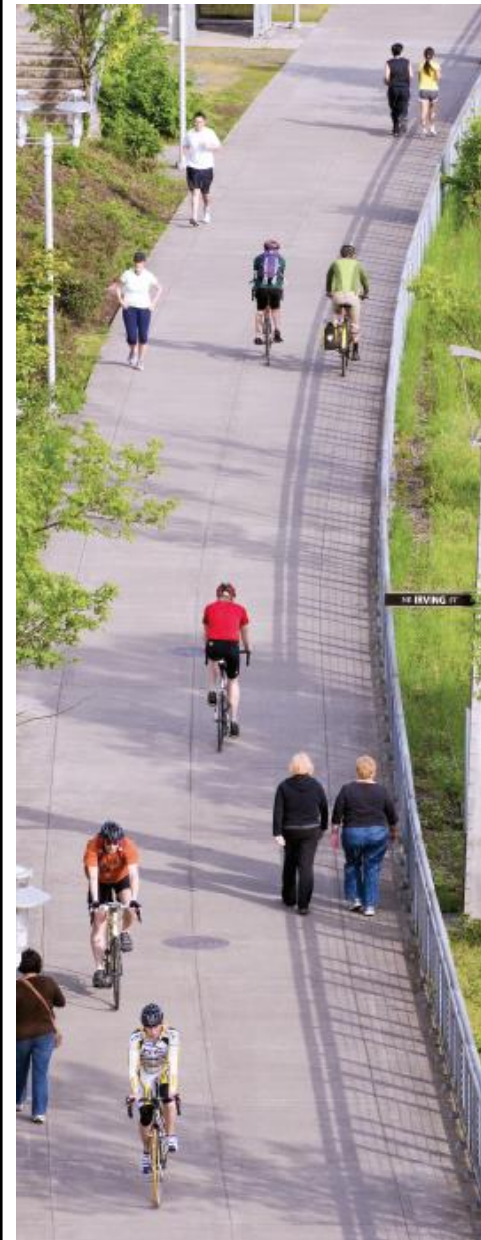
NeRC
Northwest Economic Research Center
College of Urban and Public Affairs

FINAL REPORT
NOVEMBER 2016

 Portland State
UNIVERSITY

Understanding the economic impacts of urban greenway infrastructure (2018) ([link](#))

- Funded by NITC
- In collaboration with Portland Bureau of Planning and Sustainability (BPS)
- **Research Objectives**
 - How do we characterize access to the urban greenway **network** to facilitate our understanding of its impacts on the economy?
 - What are the economic impacts of the existing bicycle/pedestrian (greenway) network in Portland? How would the City Greenways concept further impact the economy?



Understanding Economic and Business Impacts of Street Improvements for Bicycle and Pedestrian Mobility – A Multi-City Multi-Approach Exploration (2018-2019) ([link](#))

- Funded by NITC & Summit Foundation
- In collaboration with PeopleForBikes and Bennett Midland
- **Research Objectives**
 - How do corridor-level street improvements impact economic activity?
 - To develop a **systematic and rigorous** methodological approach that is **replicable** in different cities and corridors for pre-post implementation evaluation and analysis







Data

GIS Spatial Data

LEHD (Longitudinal Employment and Household Dynamics)

Sales Tax

QCEW (Quarterly Census of Employment & Wages)

NETS (National Establishment Time Series)

- Employment by Industry
- Census Block
- "Fuzzed"

- Sales Revenue
- Confidential data

- Employment & Wages
- Confidential data

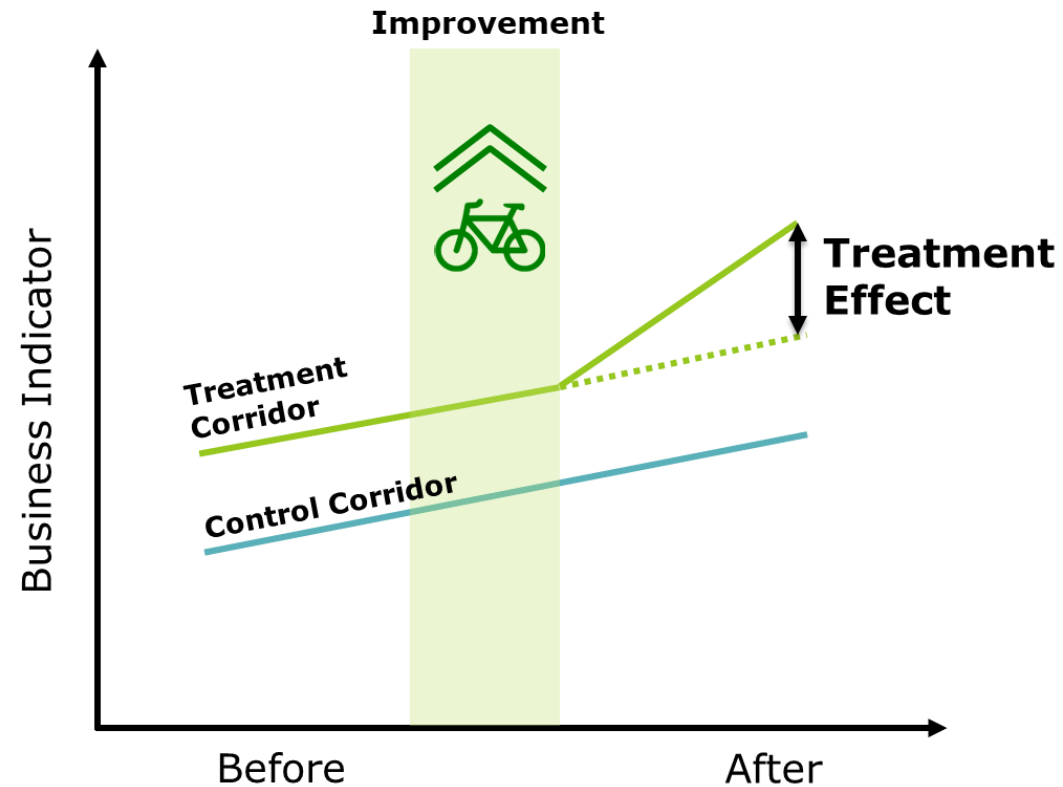
- Employment & Sales
- Proprietary

Methodology

- **Aggregated Trend Analysis**
 - Compares changes over time
 - Compares corridors with control corridors or neighborhood/city
- **Difference-in-Difference (DID)**
 - Estimates effect of new infrastructure by comparing change in employment pre-post implementation
 - Compares control and treatment corridors
- **Interrupted Time Series (ITS)**
 - Estimates effect of new infrastructure over full time period for treatment corridors

Difference-in-Difference (DID)

- Designed to answer the “but for” question
- Compares treatment and control corridors pre- and post-improvement to isolate **treatment effect**

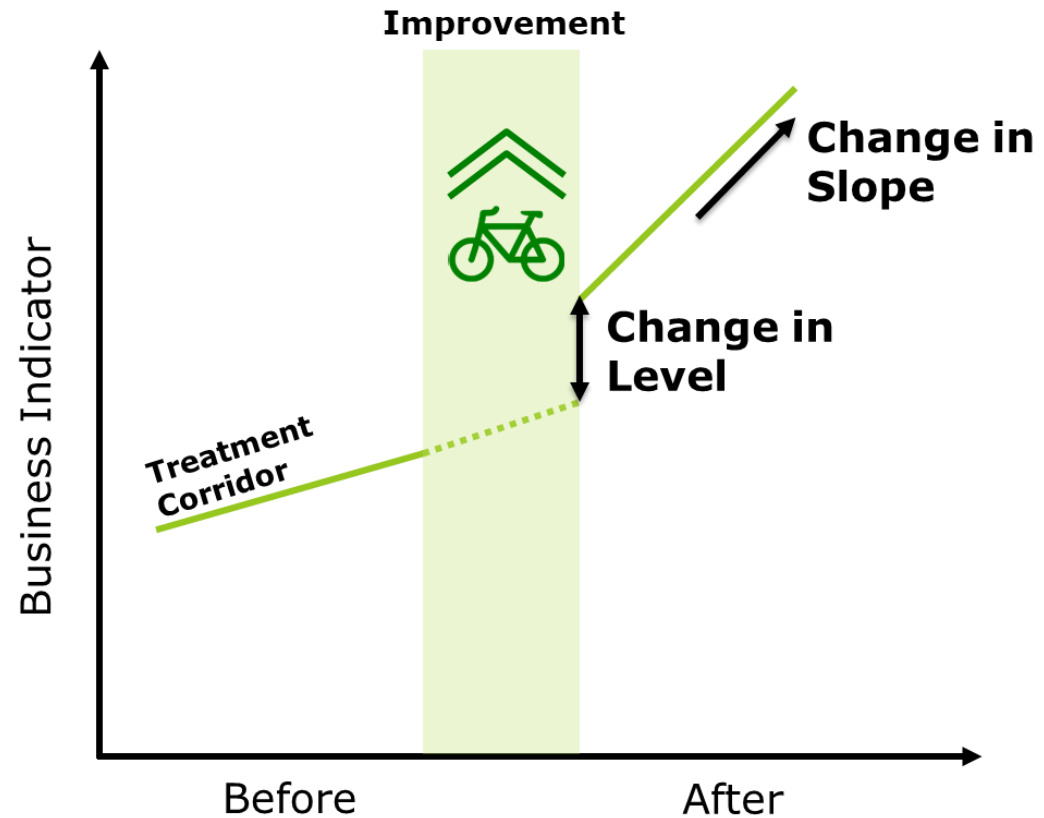


$$Y_{it} = \beta_0 + \beta_1 T_{it} + \beta_2 A_{it} + \beta_3 T_{it}A_{it} + \varepsilon_{it}$$

- Y_{it} = Outcome variable for group i at time t
- T_{it} = Dummy variable set to 1 for observation from treatment group
- A_{it} = Dummy variable set to 1 for observation from post-treatment period
- β_3 = The “difference” term. If significant and positive it indicates a positive effect of the infrastructure

Interrupted Time Series (ITS)

- Longitudinal technique to estimate the effect of treatment on a corridor
- Looks at **change in level** and **change in slope** (growth) of the corridor after treatment



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

- Y_t = Outcome variable at time t
- T_t = Time period
- X_t = Treatment dummy variable taking value of 0 in the pre- period and 1 in the post- period
- β_2 = the level change in the outcome
- β_3 = indicates the slope change following the intervention...the rate of growth

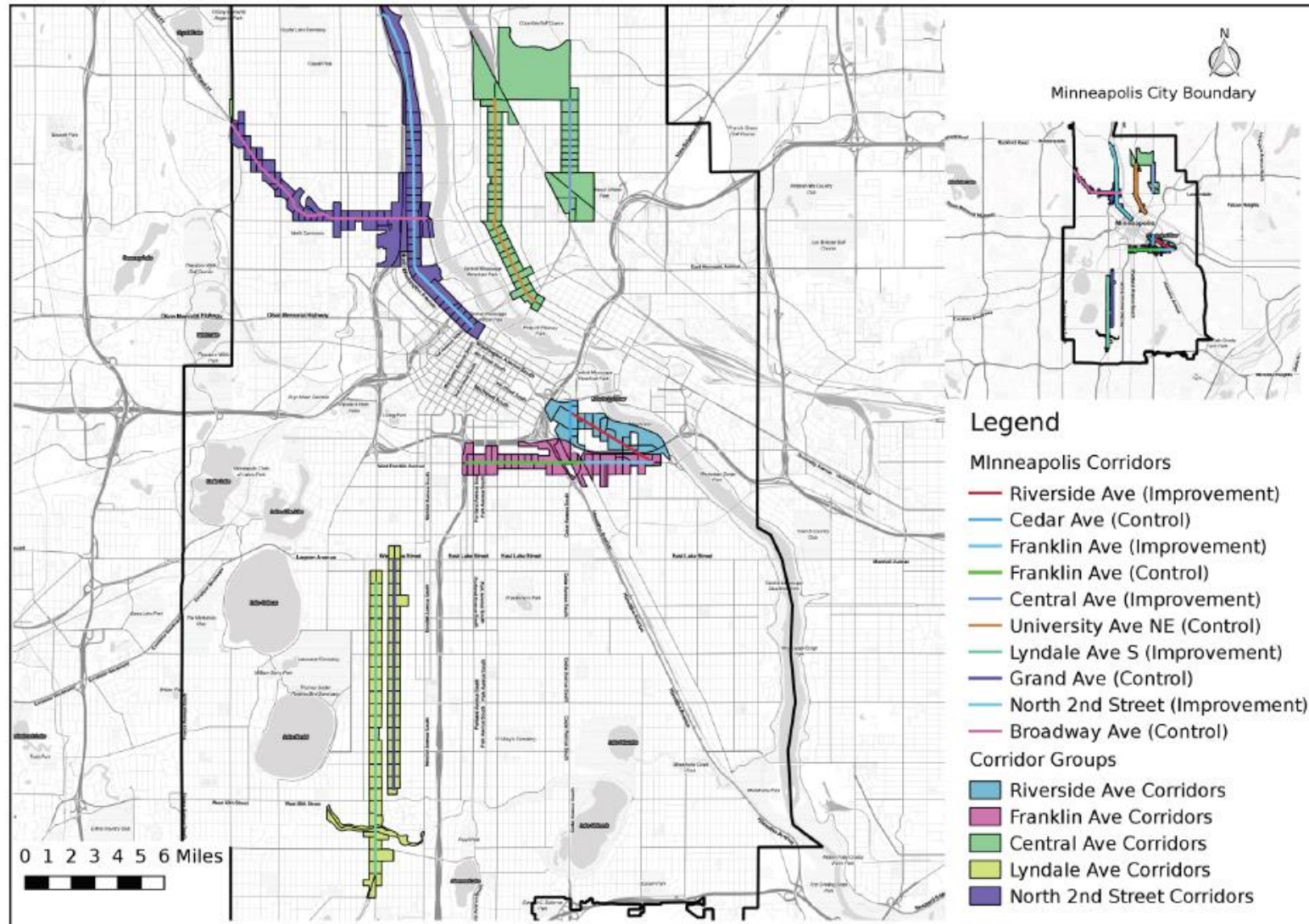
Corridor Selection

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

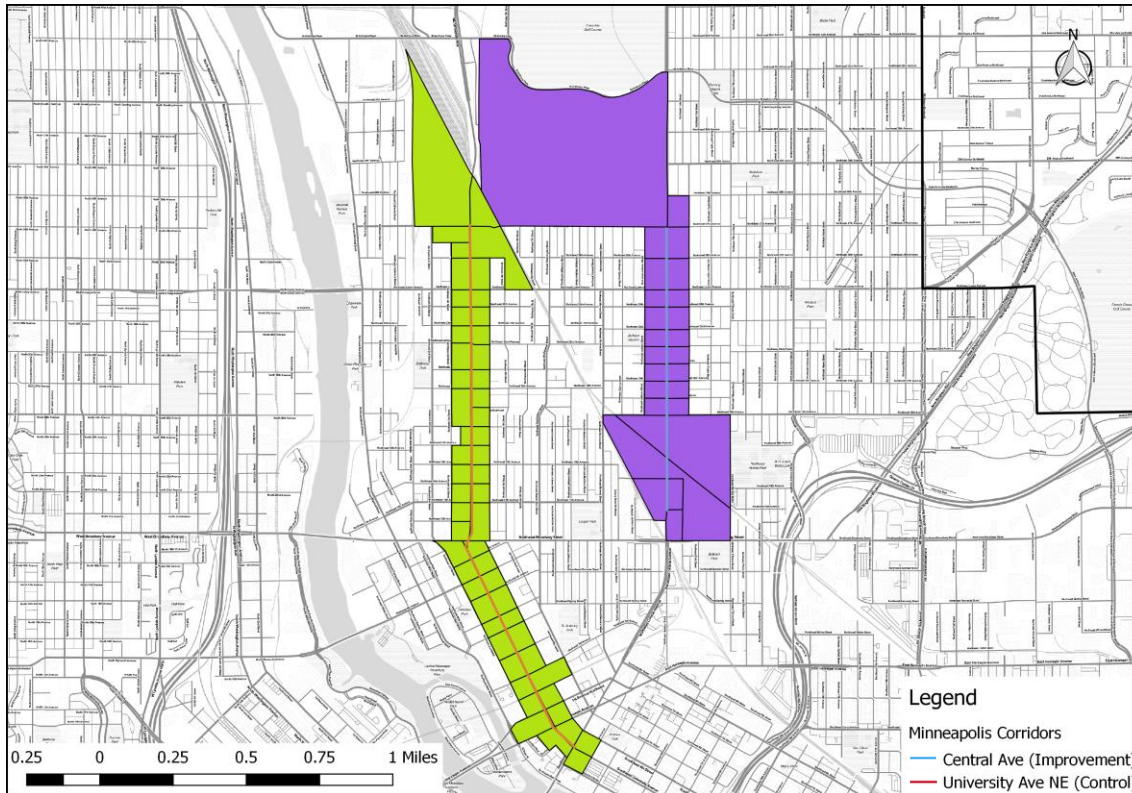
Findings from Minneapolis



Minneapolis Corridors



Minneapolis – Central Avenue (2012)



Minneapolis – Corridor Selection

Treatment Corridor	Indicator		Central	Franklin
Control Corridor			University	Franklin
Transportation/ Geography	Geographic Proximity		✓	x
	Street Classification		✓	✓
	Role in Street Network		✓	✓
Business Activity	Job Density	retail	✓	✓
	Percentile	food	x	✓
	Share of Business Jobs		✓	✓
	Employment	retail	✓	x
	Growth Rate	food	✓	x

LEHD - Employment

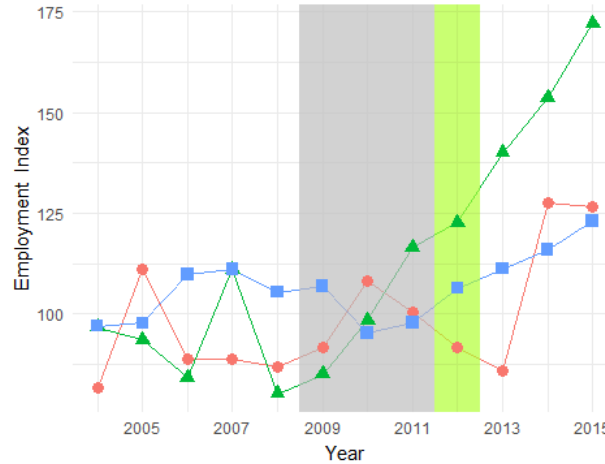
Retail Employment Comparison:
Central Ave.



Gray shaded area is pre-construction period
Green shaded area is construction period
Employment is indexed to the baseline years (3 years pre-construction)

Type ● Treatment ▲ Control: University Ave. ■ City

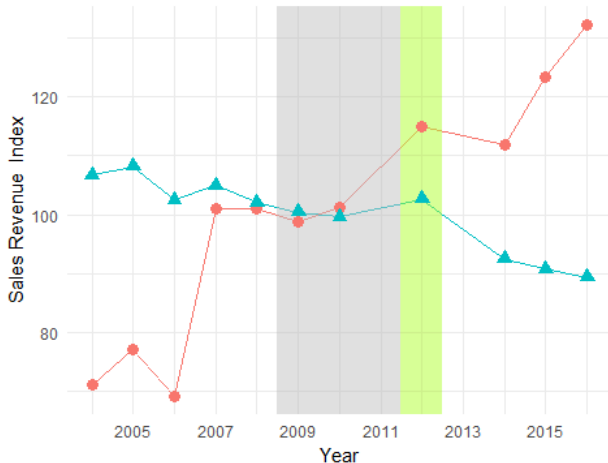
Food Employment Comparison:
Central Ave.



Gray shaded area is pre-construction period
Green shaded area is construction period
Employment is indexed to the baseline years (3 years pre-construction)

Sales Tax

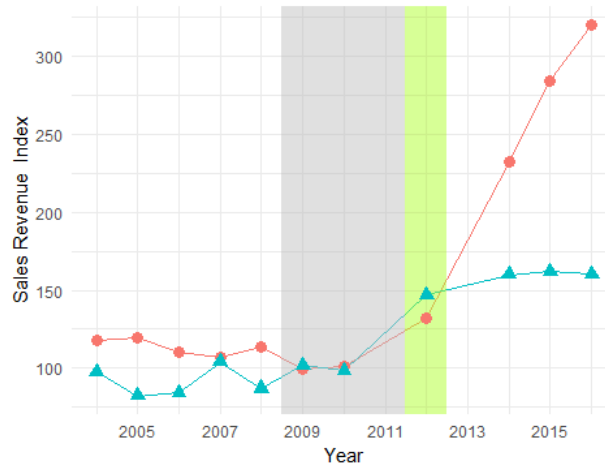
Retail Sales Revenue Comparison:
Central Ave.



Gray shaded area is pre-construction period
Green shaded area is construction period
Sales Revenue is indexed to the baseline years (3 years pre-construction)

Type ● Treatment ▲ Control: University Ave.

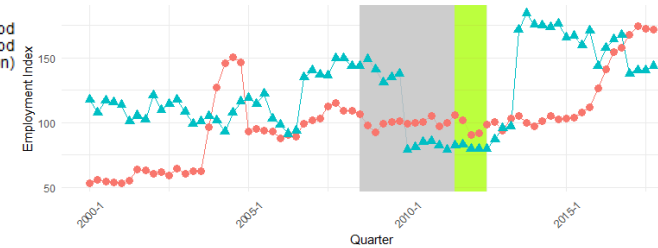
Food Sales Revenue Comparison:
Central Ave.



Gray shaded area is pre-construction period
Green shaded area is construction period
Sales Revenue is indexed to the baseline years (3 years pre-construction)

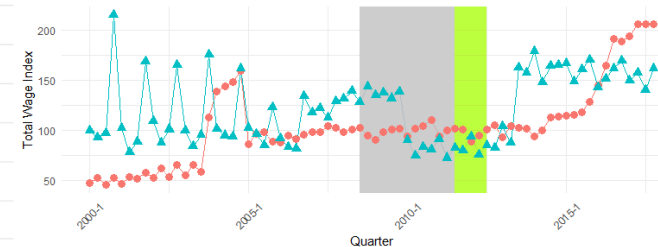
QCEW - Employment & Wages (Retail only)

Retail Employment Comparison:
Central Ave

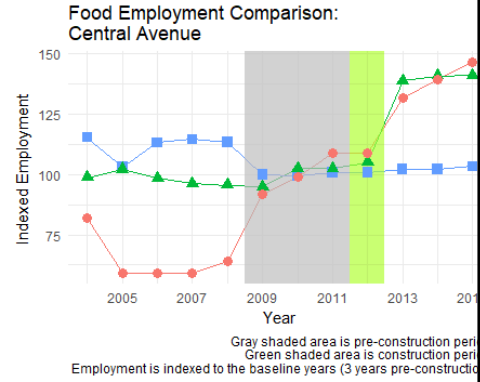
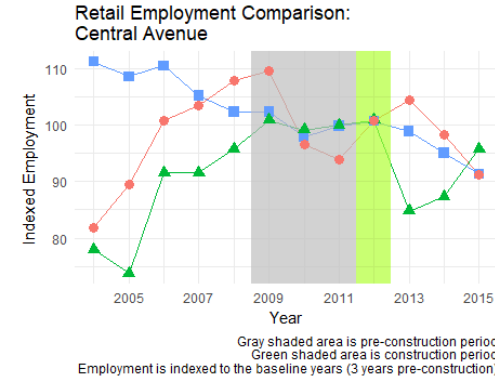
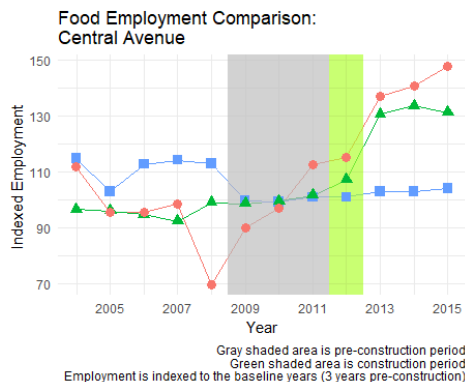
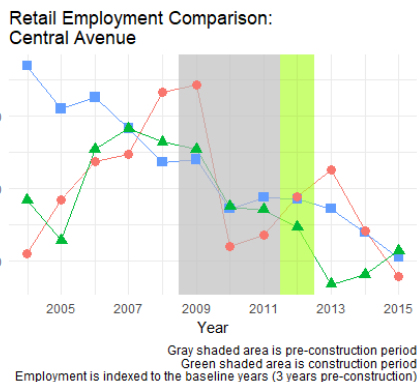
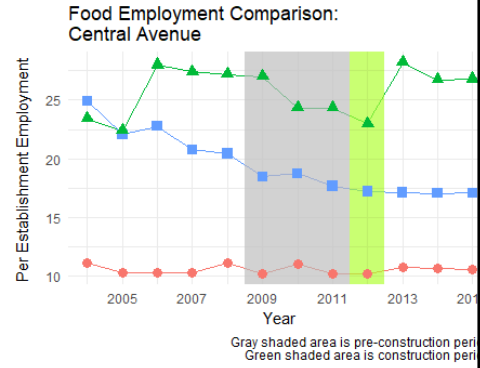
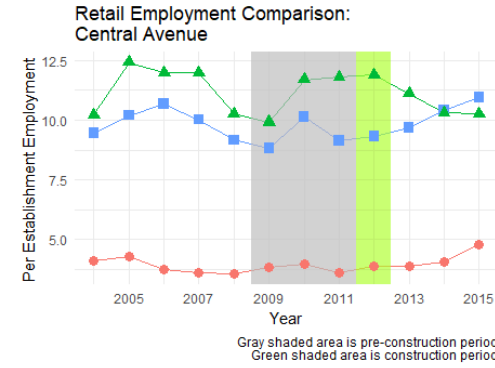
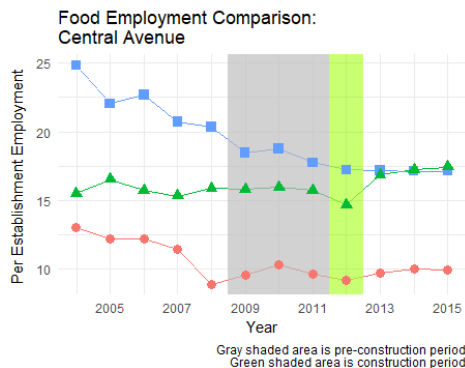
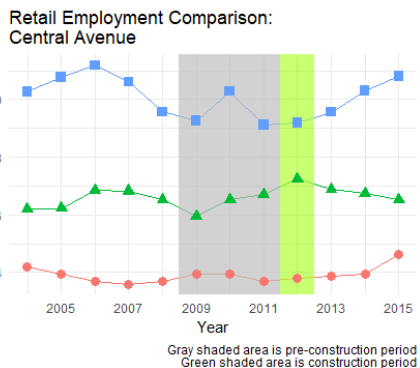
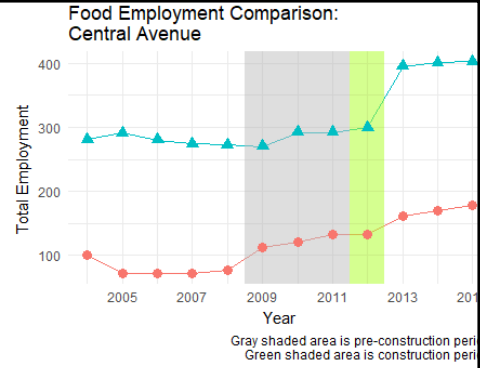
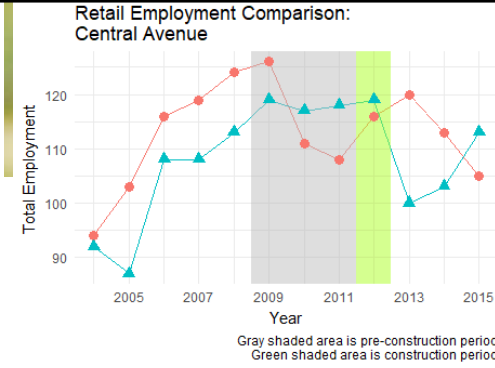
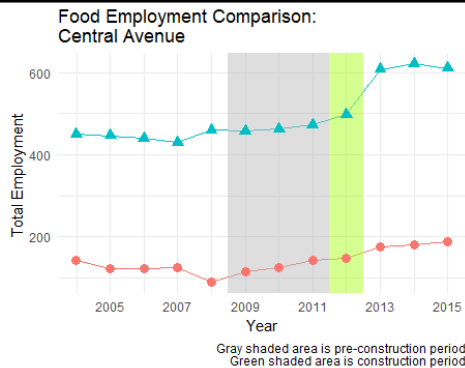


Gray shaded area is pre-construction period
Green shaded area is construction period
Data are indexed to the baseline years (3 years pre-construction)

Retail Total Wage Comparison:
Central Ave



Gray shaded area is pre-construction period
Green shaded area is construction period
Data are indexed to the baseline years (3 years pre-construction)



Type ● Treatment: Central ▲ Control: University ■ City

Type ● Treatment: Central ▲ Control: University ■ City

NETS – Type I

all retail and food service establishments on the abutting blocks of the corridor (matches LEHD)

NETS – Type II

Subset of establishments in Type I that are directly facing the corridor

Minneapolis - Central Avenue

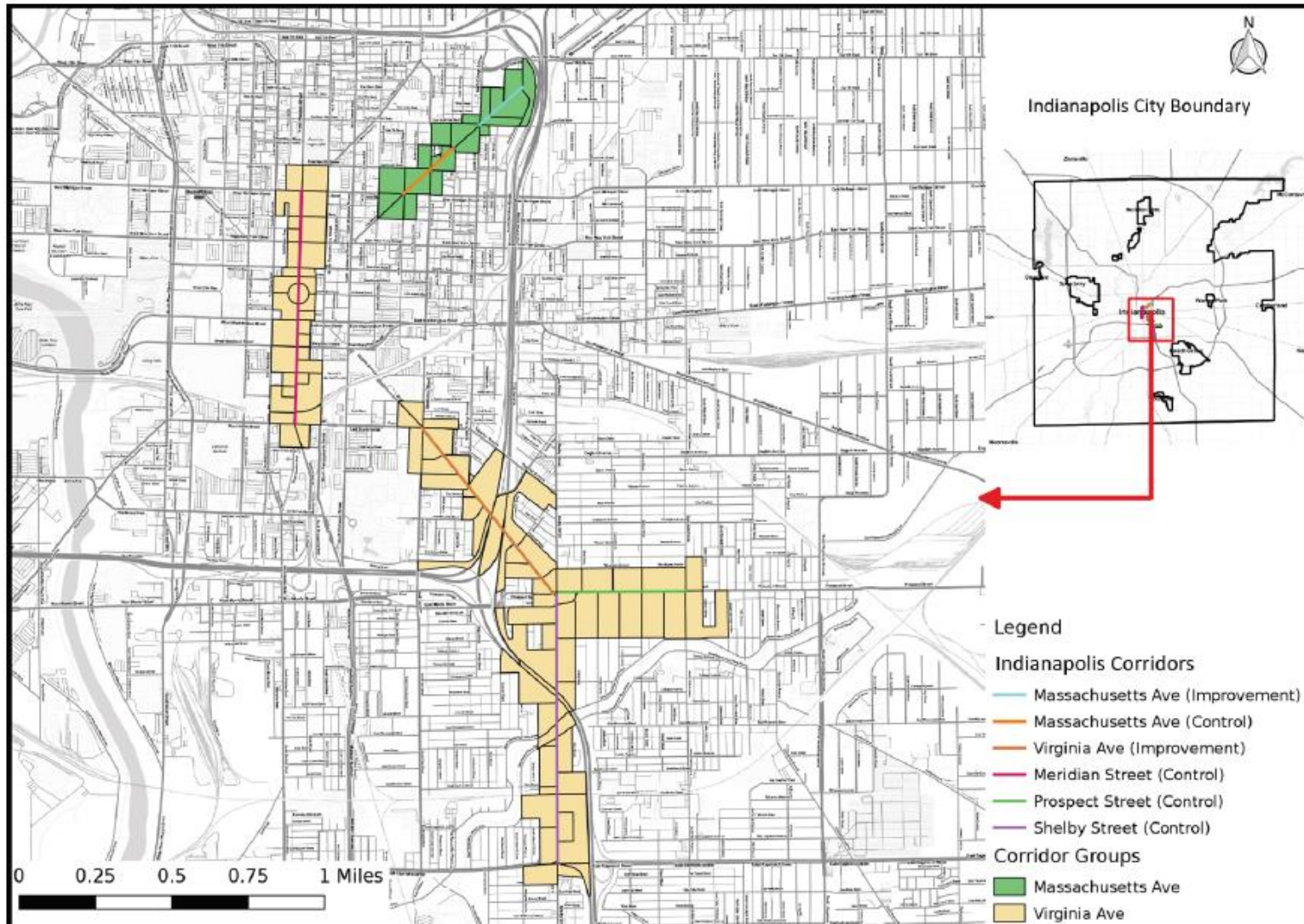
Key Findings

- Retail and food employment increased after bike lane construction
 - Employment growth on par with control corridor (trend; DID)
 - Positive significant growth rate post-construction for both employment and wages (ITS)
- Sales revenue increased in both industries
 - Results are not statistically significant for retail
 - Strong positive impact for food (trend; ITS)
- Additional mixed results using NETS
 - Transition from retail to food industry

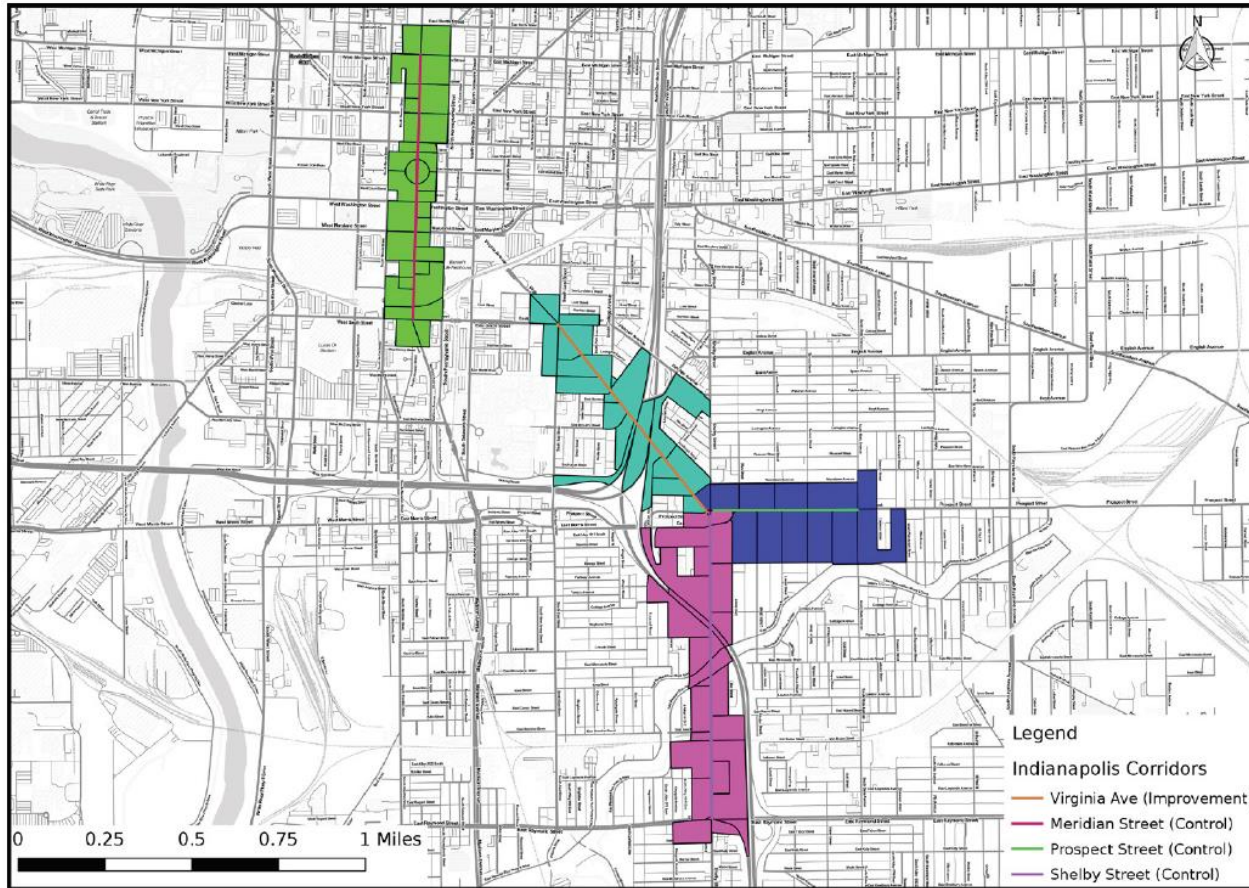
An aerial photograph of the Indianapolis skyline. In the foreground, the Indiana State Capitol building is prominent, featuring a large green dome and classical architectural details. To the left, a tall, modern skyscraper with a grid-like facade stands out. In the center-right, another tall skyscraper with a distinctive pointed top and multiple antennas is visible. The city extends into the distance under a clear blue sky. A semi-transparent white banner is overlaid across the middle of the image, containing the text "Findings from Indianapolis" in a bold, green, sans-serif font.

Findings from Indianapolis

Indianapolis Corridors



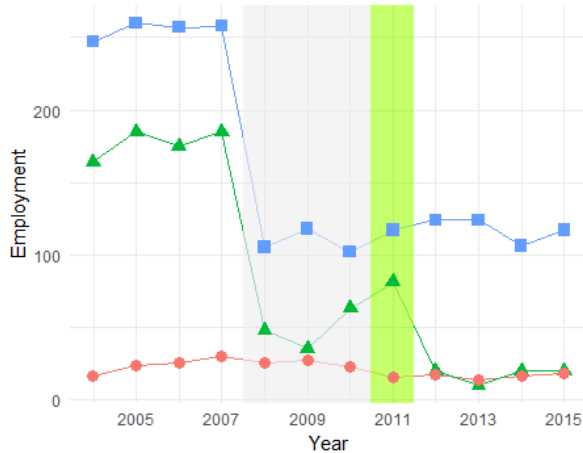
Indianapolis – Virginia Avenue (2011)



Indianapolis – Corridor Selection

Treatment Corridor	Indicator		Virginia		
Control Corridor			Meridian	Prospect	Shelby
Transportation/ Geography	Geographic Proximity		✓	✓	✓
	Street Classification		✓	✓	✓
	Role in Street Network		✓	✓	✓
Business Activity	Job Density Percentile	retail	x	x	x
		food	x	✓	✓
	Share of Business Jobs		✓	✓	✓
	Employment Growth Rate	retail	✓	✓	✓
		food	✓	✓	✓

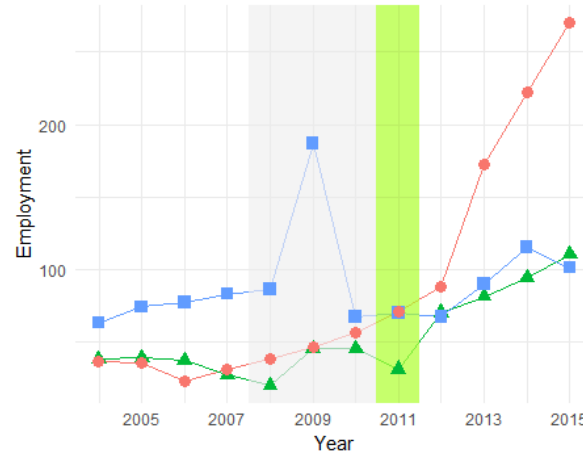
Retail Employment Comparison:
Virginia Ave.



Gray shaded area is pre-construction period
Green shaded area is construction period

Type — Treatment — Control: Prospect — Control: Shelby

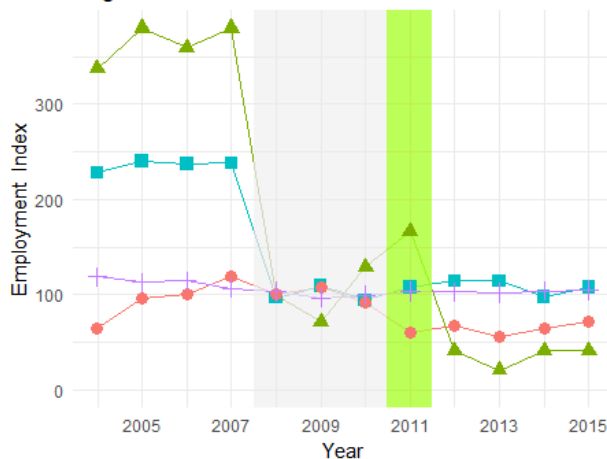
Food Employment Comparison:
Virginia Ave.



Gray shaded area is pre-construction period
Green shaded area is construction period

LEHD - Employment

Retail Employment Comparison:
Virginia Ave.

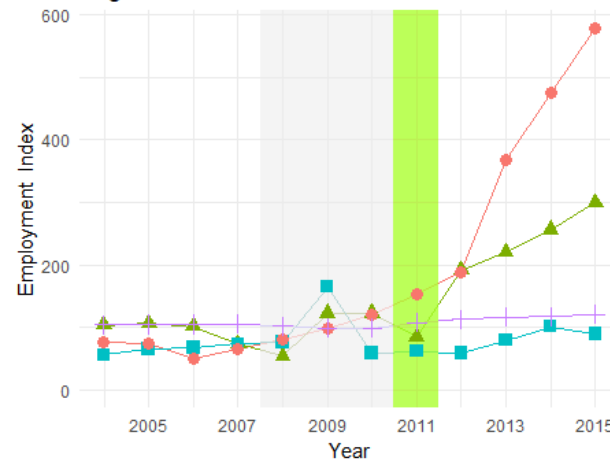


Gray shaded area is pre-construction period
Green shaded area is construction period

Employment is indexed to the baseline years (3 years pre-construction)

Type — Treatment — Control: Prospect — Control: Shelby — City

Food Employment Comparison:
Virginia Ave.



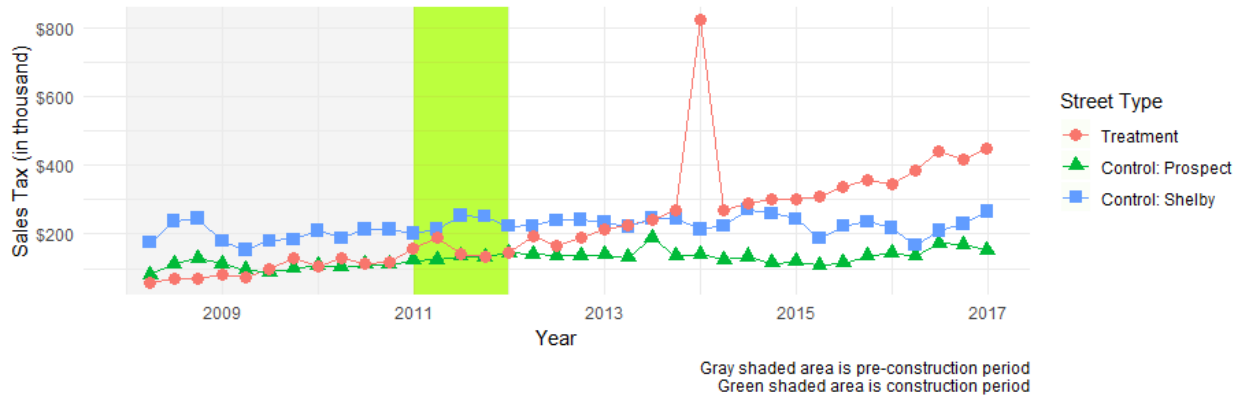
Gray shaded area is pre-construction period
Green shaded area is construction period

Employment is indexed to the baseline years (3 years pre-construction)

Type — Treatment — Control: Prospect — Control: Shelby — City

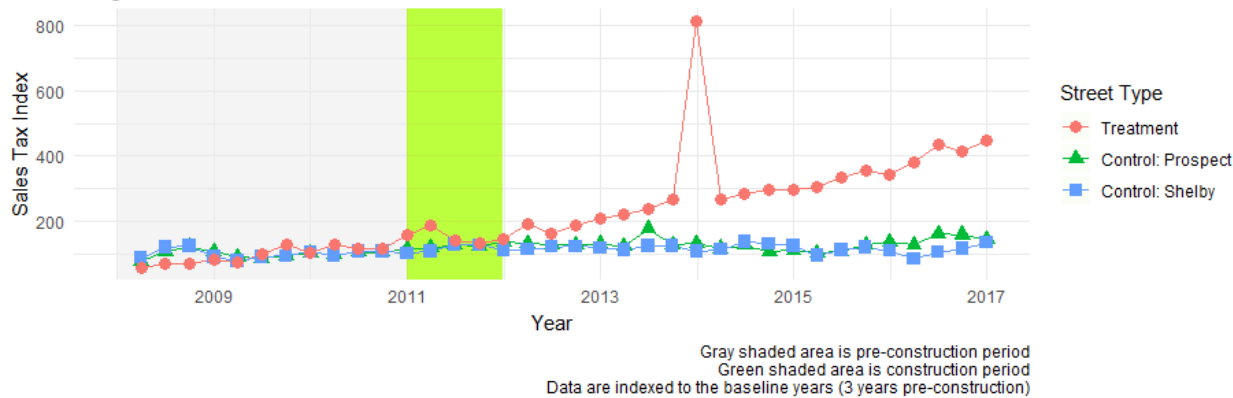
LEHD - Indexed Employment

Sales Tax Comparison:
Virginia Ave.



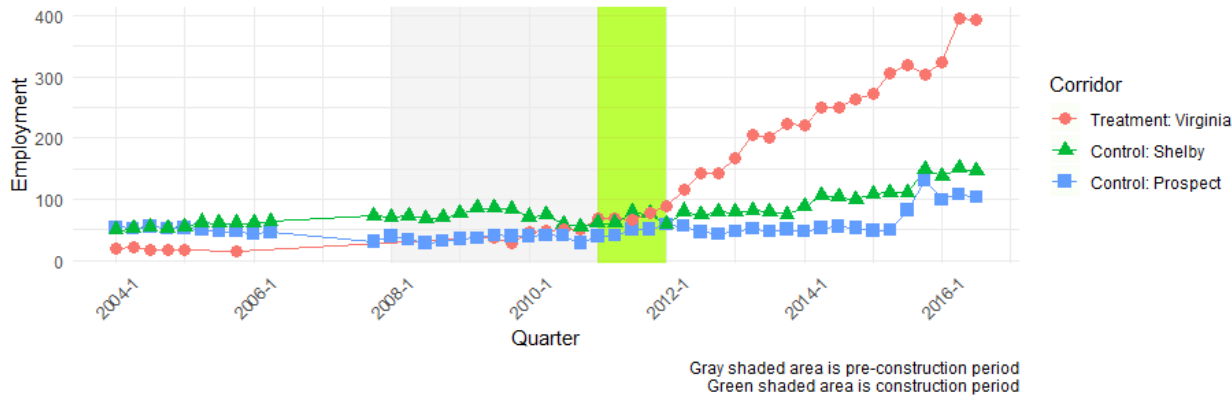
Sales Tax

Sales Tax Comparison:
Virginia Ave.

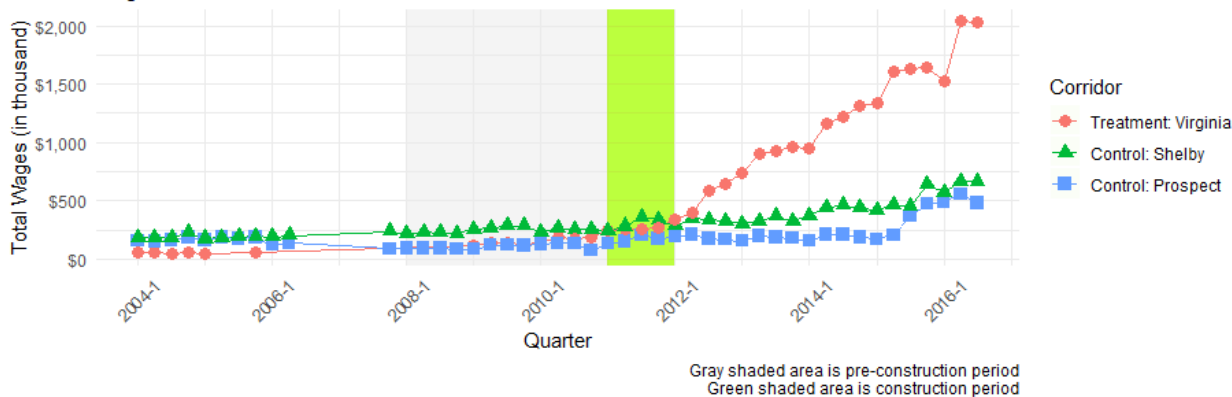


Indexed Sales Tax

Food and Drinking Places Employment Comparison
Virginia Ave



Food and Drinking Places Total Wages Comparison
Virginia Ave



**QCEW –
employment &
wages**
(food and drinking
places only)

Indianapolis – Virginia Avenue

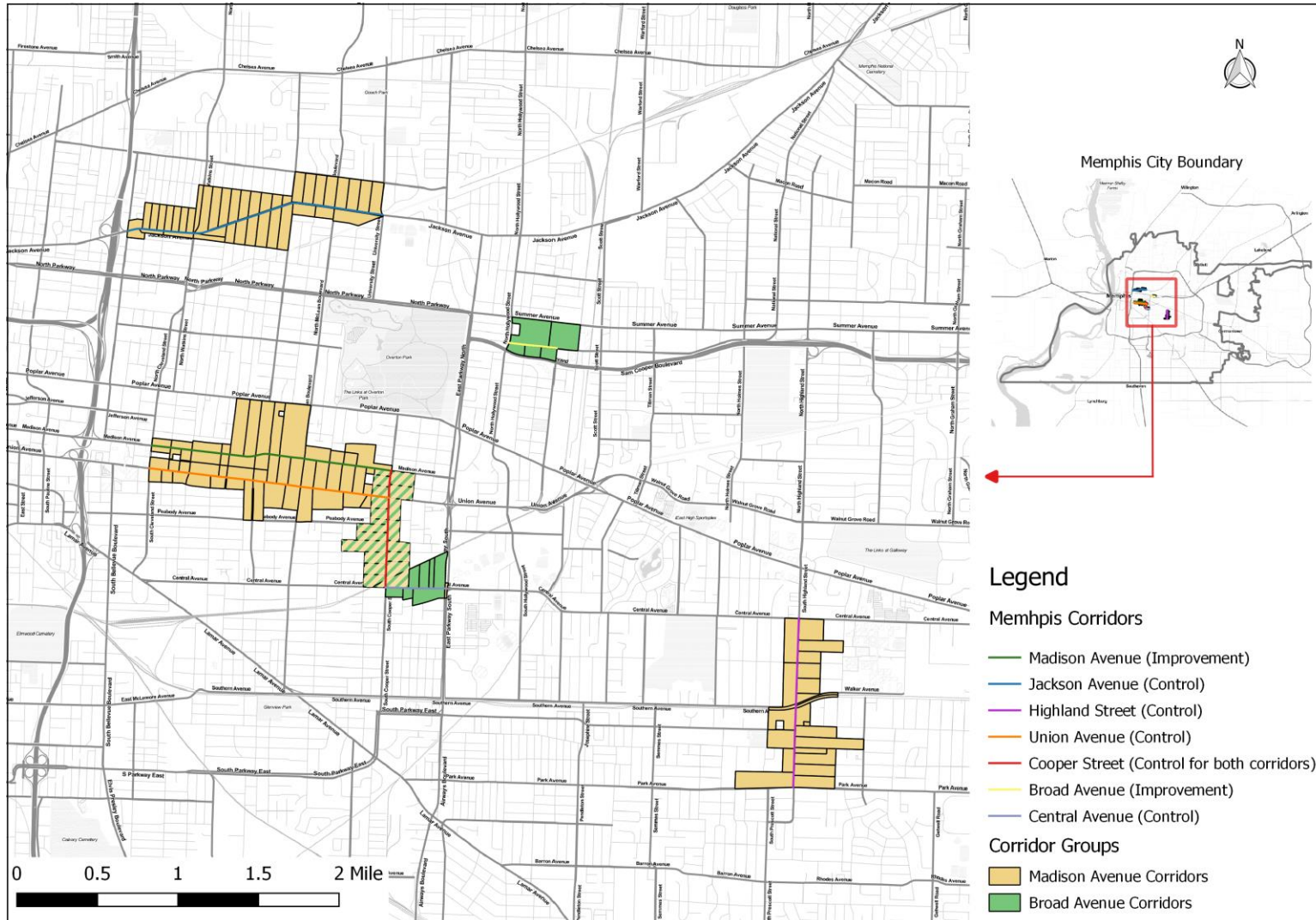
Key Findings

- Retail employment unaffected by bike lane installation
 - Aggregated trend analysis shows some negative or stagnant growth
 - DID and ITS showed no statistically significant impacts
- Food employment, wages and sales – substantial growth following bike lane installation
 - DID and ITS indicate positive causal impacts
 - Consistent results across data sources

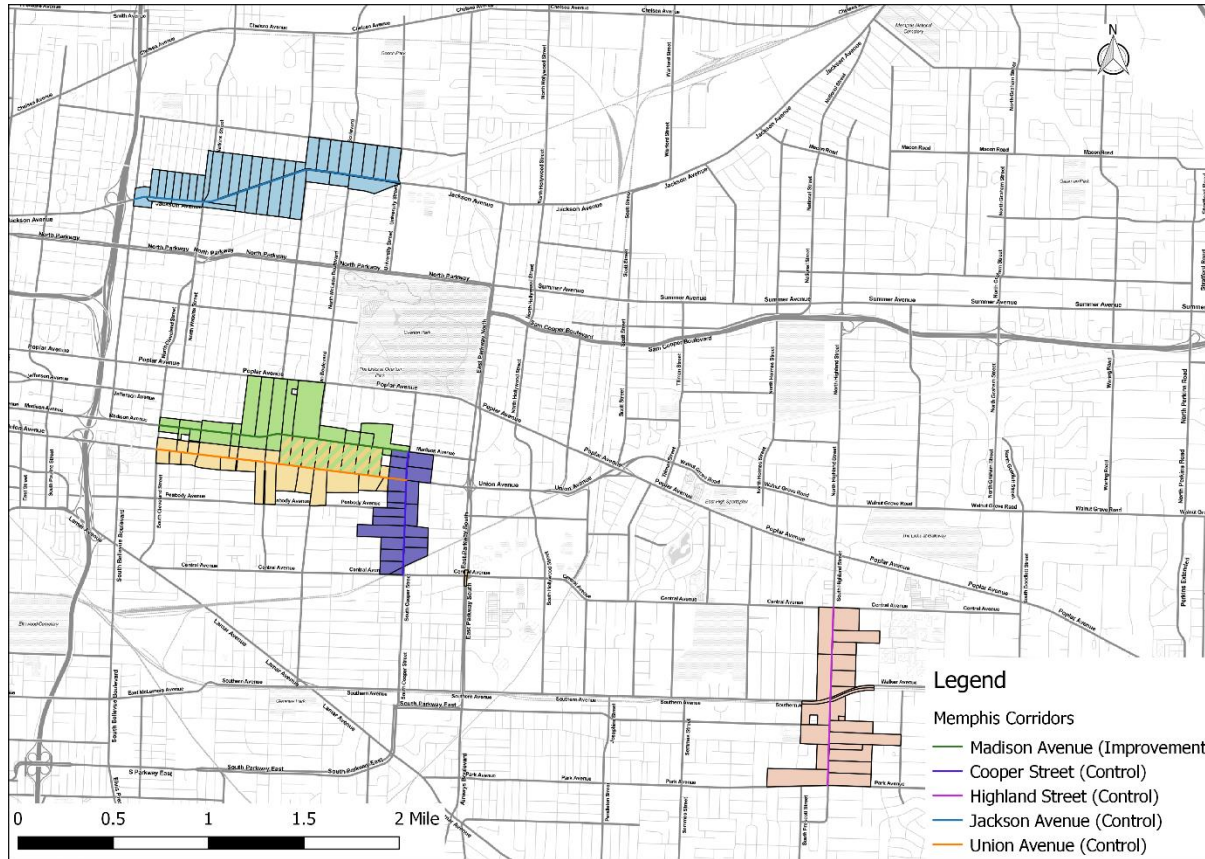
Findings from Memphis



Memphis Corridors



Memphis – Madison Avenue (2011)



Memphis – Corridor Selection

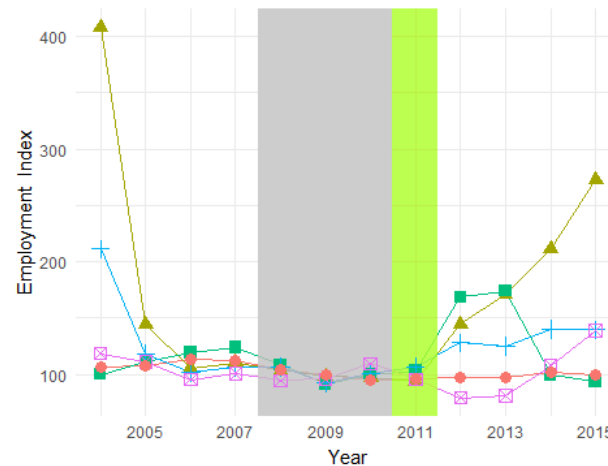
Treatment Corridor	Indicator		Madison Avenue			
Control Corridor			Cooper	Highland	Jackson	Union
Transportation/ Geography	Geographic Proximity		✓	x	x	✓
	Street Classification		✓	✓	✓	x
	Role in Street Network		✓	✓	✓	x
Business Activity	Job Density Percentile	retail	✓	✓	x	✓
		food	✓	✓	x	✓
	Share of Business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

Retail Employment Comparison:
Madison Ave.



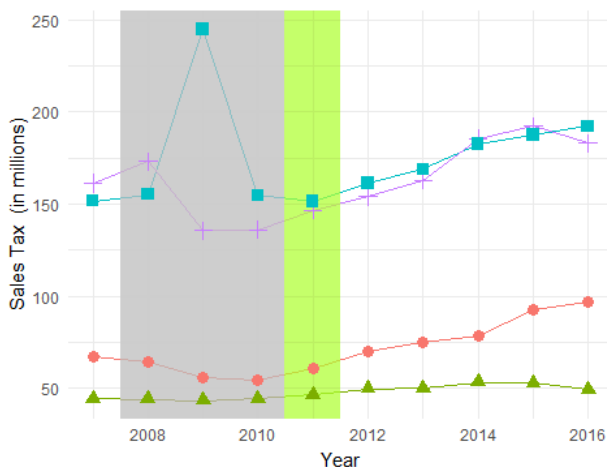
Gray shaded area is pre-construction period
Green shaded area is construction period
Employment is indexed to the baseline years (3 years pre-construction)

Food Employment Comparison:
Madison Ave.



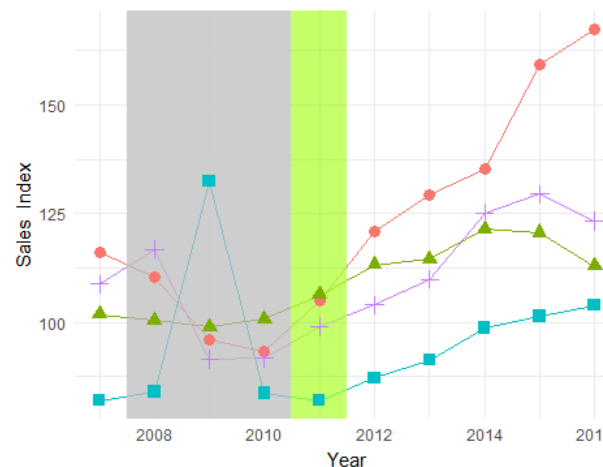
Gray shaded area is pre-construction period
Green shaded area is construction period
Employment is indexed to the baseline years (3 years pre-construction)

Retail Sales Tax Comparison:
Madison Ave.



Gray shaded area is pre-construction period
Green shaded area is construction period

Retail Sales Comparison:
Madison Ave.



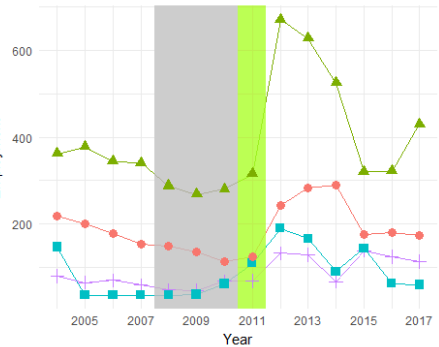
Gray shaded area is pre-construction period
Green shaded area is construction period
Sales is indexed to the baseline years (3 years pre-construction)

Type ● Control: S Cooper St ▲ Control: S Highland St ■ Control: Union Ave + Treatment: Madison Ave

LEHD – Indexed Employment

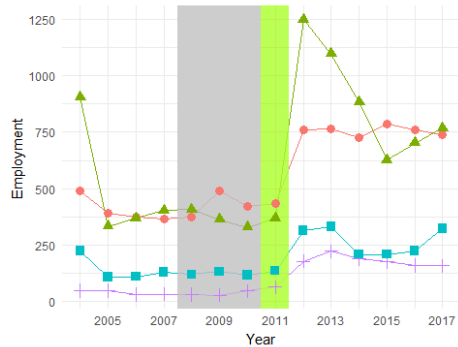
Sales Tax – Retail only

Retail Employment Comparison:
Madison Avenue



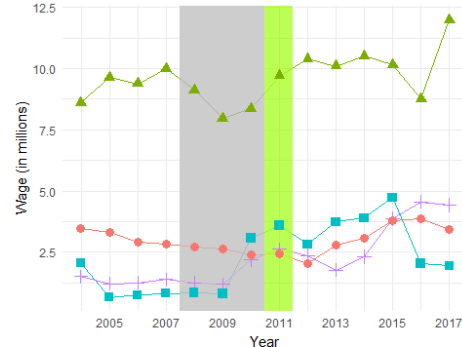
Gray shaded area is pre-construction period
Green shaded area is construction period

Food Employment Comparison:
Madison Avenue



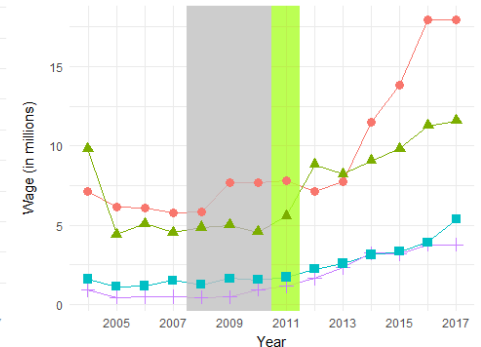
Gray shaded area is pre-construction period
Green shaded area is construction period

Retail Wage Comparison:
Madison Avenue



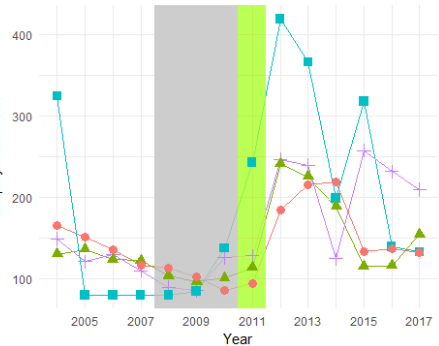
Gray shaded area is pre-construction period
Green shaded area is construction period

Food Wage Comparison:
Madison Avenue



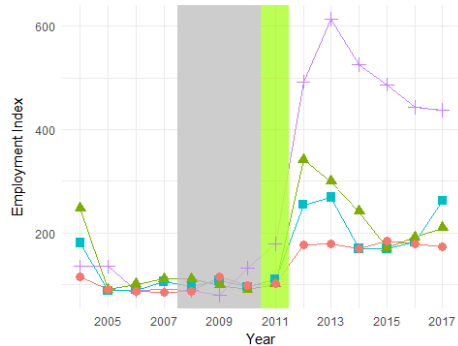
Gray shaded area is pre-construction period
Green shaded area is construction period

Retail Employment Comparison:
Madison Avenue



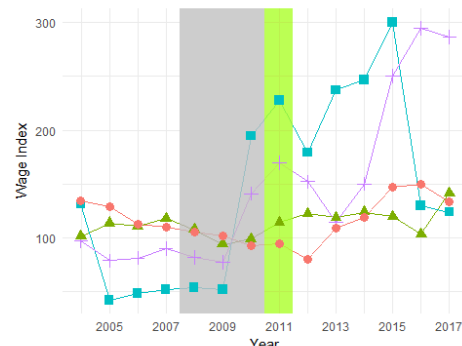
Gray shaded area is pre-construction period
Green shaded area is construction period
Employment is indexed to the baseline years (3 years pre-construction)

Food Employment Comparison:
Madison Avenue



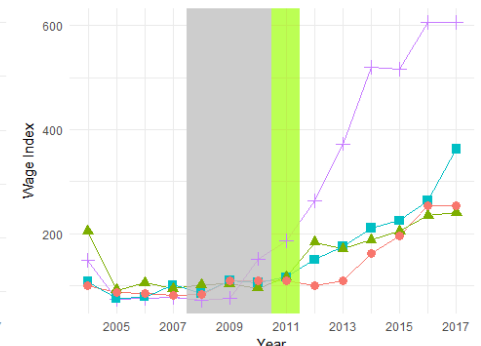
Gray shaded area is pre-construction period
Green shaded area is construction period
Employment is indexed to the baseline years (3 years pre-construction)

Retail Wage Comparison:
Madison Avenue



Gray shaded area is pre-construction period
Green shaded area is construction period
Wage is indexed to the baseline years (3 years pre-construction)

Food Wage Comparison:
Madison Avenue



Gray shaded area is pre-construction period
Green shaded area is construction period
Wage is indexed to the baseline years (3 years pre-construction)

Type — Treatment: Madison Ave — Control: Union Ave — Control: S Highland St — Control: S Cooper St

Type — Treatment: Madison Ave — Control: Union Ave — Control: S Highland St — Control: S Cooper St

QCEW - Employment

QCEW - Wages

Madison Ave. Corridor Interrupted Time Series Estimates (Employment)

Dependent variable:

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

Note: $p < 0.1$; $p < 0.05$; $p < 0.01$

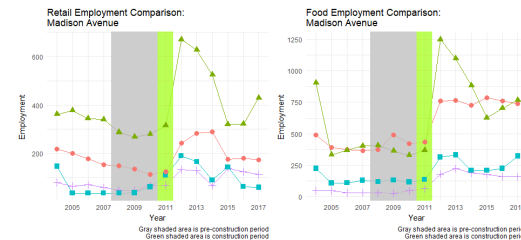
Madison Ave. Corridor Interrupted Time Series Estimates (Wage)

Dependent variable:

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

Note: $p < 0.1$; $p < 0.05$; $p < 0.01$

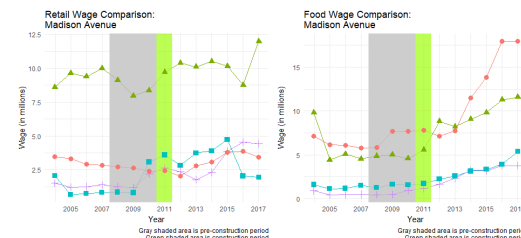
Change in level



QCEW ITS Estimations – Employment & Wages

Change in level

Change in slope








Memphis – Madison Avenue

Key Findings

- Aggregated trend analysis generally showed similar trends to control corridors
- DID indicated non-significant or mixed impacts
- ITS results showed strong positive and statistically significant impacts
 - Food and retail employment – positive level change (QCEW)
 - Food and retail wages – negative level change but strong positive growth trend (QCEW)

Corridor	Data Source	Methodology					
		Aggregated Trend		DID		ITS	
		Retail	Food	Retail	Food	Retail	Food
Minneapolis, MN							
Central Ave.	LEHD	0	0	0	-	+	+
	Retail Sales	+	+	+	-	0	+
	QCEW	+		0		+	
	NETS	0	0	0	0	0	0
Memphis, TN							
Madison Ave.	LEHD	0	0	0	0	0	+
	Retail Sales	+	+	0	0	+	+
	QCEW	0	+	0	0	+	+
	NETS	0	0	0	0	0	0

IMPROVEMENT TYPE		KEY FINDINGS
MINNEAPOLIS		
CENTRAL AVENUE (2012)		
 	RETAIL	Retail employment increased: The ITS approach shows a positive growth trend from the bike lane construction using LEHD data and QCEW wages data.
 	FOOD SERVICE	Dramatic increase in restaurant sales, along with increase in food service employment following installation (confirmed by both trend analysis and the ITS approach).
MEMPHIS		
MADISON AVENUE (2011)		
	RETAIL	Positive and statistically significant improvement in retail sales. A slight increase in retail employment after the 2011 installation was followed by decreases in retail employment. Madison performed worse than two of the three control corridors and worse than city-wide, indicating that the street improvement on Madison may have had a negative impact on retail employment.
	FOOD SERVICE	Significant positive impact on food employment: After bike lane installation, food employment dropped significantly in level, but dramatically recovered & surpassed previous levels over the next two years.

Conclusions & Limitations

- **Multiple data sources**
 - Pros & cons
 - Different economic indicators
- **Multiple methods**
 - Control corridors or areas
 - Causal inference
- **Limitations**
 - Industry shift
 - Size or type of establishments
 - Controlling for other policies or factors



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Jenny H. Liu, Ph.D. | jenny.liu@pdx.edu

Faculty Bio [Page](#) | TREC Researcher [Page](#)

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- Summary report ([link](#))
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