# Do New Bike Share Stations Increase Member Use?: A Quasi-Experimental Study

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Acknowledgement:
NSF Sustainable Research Network Funding, Dr. Anu Ramaswami, PI

# *Message for Today*

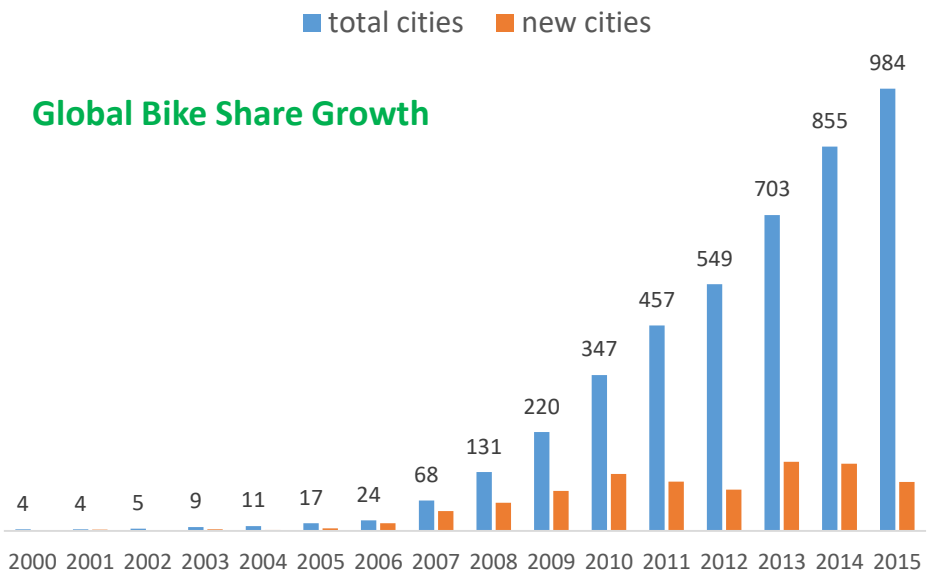
## Do New Bike Share Stations Increase Member Use?

- Yes, improved accessibility increases member frequency of use

- Implications
  - Managers can increase accessibility and better serve users
  - Bike facility investments may increase impacts of accessibility

- Contributions
  - Panel study, DID research design moves beyond correlation
  - Document heterogeneous effects of accessibility in different built environment settings

# Background




Data Source: https://www.google.com/maps/d/u/0/viewer?mid=1UxYw9YrwT_R3SGsktJU3D-2GpMU&hl=en&ll=-2.2302840762133975%2C8.8138235999999978&z=1

# Previous Studies

## Bike Share Users

- Socio-demographic characteristics
    - White
    - Higher income
    - Young
    - Higher educated
- Less is known about behaviors/ demand of current users

## Bike Share Demand

- Station-level analyses
- Correlates of bike share demand
    - Socio-demographics
    - Land use/built form
    - Transportation infrastructure
    - Time/weather

# Previous Studies

## Bike Share Accessibility

- Correlates of bike share use
- Research designs: cross-sectional analyses
    - Establish only correlation
    - Do not establish causality
    - Have not controlled for heterogeneous effects of different built environment settings

# Research Questions

## Research Question 1

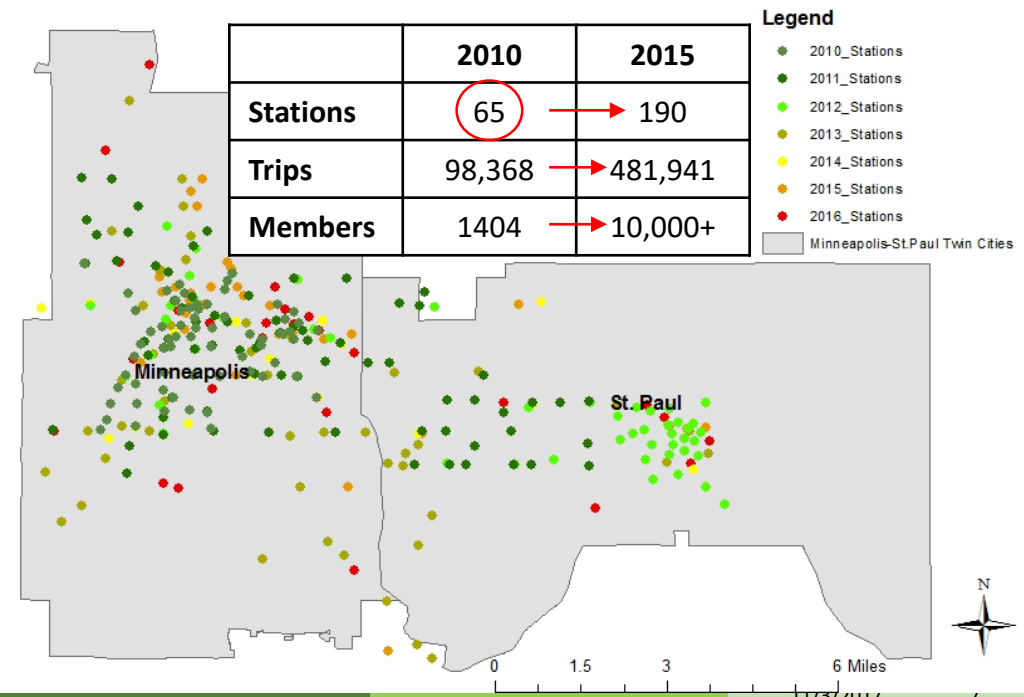
- How does improvement of accessibility to bike share stations influence frequency of use by annual members? (Causality)

## Research Question 2

- How do impacts of accessibility differ in different contexts, specifically, in relation to different features of the built environment settings?

# Nice Ride Bike Share System In Twin Cities

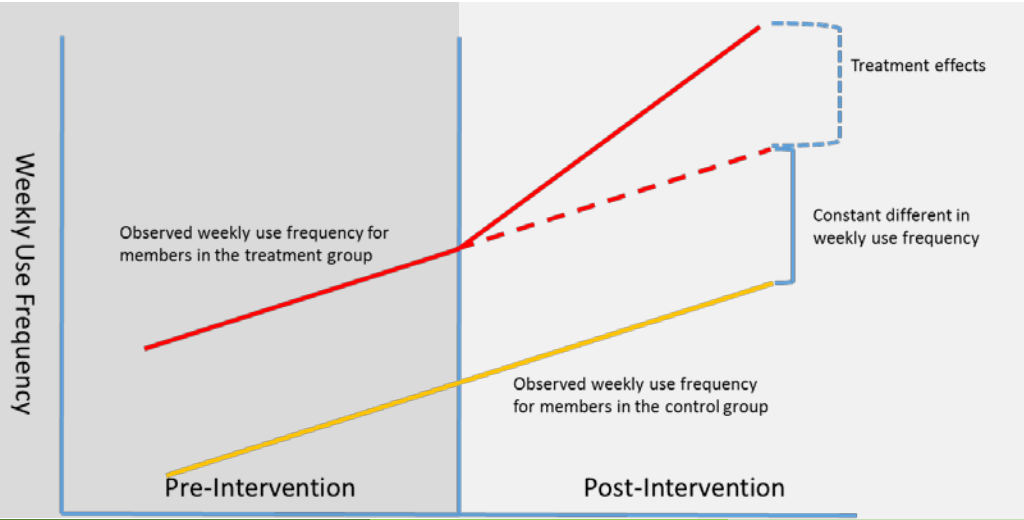
| | 2010 | 2015 |
|---|---|---|
| Stations | 65 | 190 |
| Trips | 98,368 | 481,941 |
| Members | 1404 | 10,000+ |



# Nice Ride Bike Share System In Twin Cities

| | Annual Members | 30-day Users | Casual Users |
|---|---|---|---|
| Number of Trips in 2010 | 44,284 (46%) | 1,794 (1%) | 52,290 (53%) |
| Number of Trips in 2015 | 180,245 ( 37%) | 141,781 (29%) | 159,915 (33%) |
| Average Weekly Use Frequency in 2010 | 2.7 | NA | NA |
| Average Weekly Use Frequency in 2015 | 1.4 | NA | NA |

## A Quasi-Experimental, Difference-In-Difference Modeling



## A Quasi-Experimental, Difference-In-Difference Modeling

$D_{it}$: The treatment, network distance from home addresses to the nearest bike station

$$Y_{it} = \sigma D_{it} + \gamma X_{it} + \alpha_i + \eta_t + \nu_{it}$$

$Y_{it}$: Weekly use frequency by annual members

$X_{it}$: Time and member variant variables (Bike facilities and LRT)

$\alpha_i$: The time-invariant error term

$\eta_t$: Common unobserved time trends

$\nu_{it}$: The error term with standard properties

$$Y_{it} = X_i D_{it} \beta + \sigma D_{it} + \gamma X_{it} + \alpha_i + \eta_t + \nu_{it}$$

$X_i$: Time-invariant variables, mainly built environment

# Research Design

## Datasets

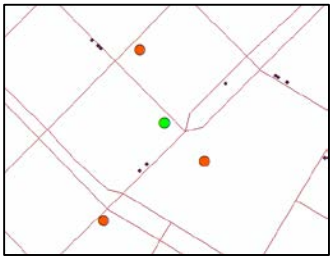
| Data | Sources |
| --- | --- |
| A five-year panel data set of members' bike share trips from 2010 to 2015 | Nice Ride |
| Land use | Metropolitan Council |
| 2010-2015 five-year bike lane/trail dataset | City of Minneapolis and St. Paul |
| Street network | Metropolitan Council |

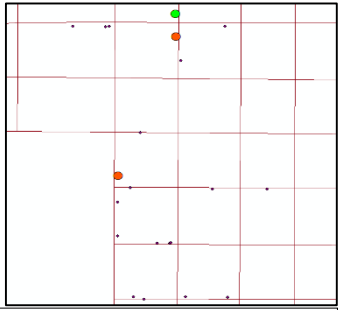
# Research Design

## Three Different Models

| Model 1 | Model 2 (Dit<1/4 mile) | Model 3 (Dit>1/4 |
|---|---|---|

All members living within 3 miles of stations





home addresses  2011 stations  2015 stations

# Research Design

## Three Different Models

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| | Dit ≤ 3 miles | Dit ≤ ¼ miles | ¼ miles< Dit≤3 miles |
| Total N (NT) | 9,510 (450,753) | 5,043 (217,878) | 4,467 (125,477) |
| N (NT) in the treatment | 1,370 (107,398) | 225 (16,230) | 1,145 (91,168) |
| N (NT) in the control group | 8140 (343,355) | 4,818 (234,108) | 3,322 (216,645) |
| Weekly Use (Mean/St.d) | 1.7 (3.5) | 2.0 (3.7) | 1.4 (3.2) |

## Modeling Approach

- Fixed effect Poisson models
  - Count data
  - Conditional likelihood of negative binomial fixed effects model is problematic

# Descriptive Statistics

| Variable | Mean | Std. Dev. |
|---|---|---|
| **Treatment Variable (NT=450, 753)** | | |
| Distance ($10^{-1}$ mile) | 5.44 | 8.3 |
| **Weekly Observation Level (NT=450, 753)** | | |
| Bike Lane Length (meters) | 1124 | 1212 |
| LRT | 0.06 | 0.24 |
| **Member Level (N=9510)** | | |
| Female (N=9434)* | 0.43 | 0.5 |
| Job density | 0.007 | 0.04 |
| Pop density | 0.008 | 0.008 |
| % Recreation | 0.21 | 0.23 |
| % Retail | 0.40 | 0.44 |
| % Office | 0.07 | 0.13 |
| % Industrial | 0.17 | 0.33 |

# Basic DID Model Estimation Results

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | Coef. | IRR | Coef. | IRR | Coef. | IRR |
| **Distance** | -0.002 | 0.998 | -0.12 | 0.89 | -0.001 | 0.999 |
| **Bikeway** | 0.0001 | 1.0001 | 0.0001 | 1.0001 | 0.00002 | 1.00002 |
| **LRT** | -0.11 | 0.89 | -0.07 | 0.93 | -0.61 | 0.54 |
| | | | | | | |
| **Log Likelihood** | -740042.75 | | -421590.06 | | -317939.09 | |

- Distance has significant, negative effects on frequency of member use
- 0.1 mile increase in distance decreases the weekly use for members in model 2 by 11% (1-0.89). If 0.1 mile increase in distance, the average frequency to use would decrease from 2 to 1.76
- The substitutional effect of transit on bike share is larger in Model 3

# *Effects of Access are Heterogeneous*

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| | Coef. | Coef. | Coef. |
| LRT | - | - | - |
| Bikeway Length | + | + | + |
| Distance*LRT | - | - | - |
| Distance*Bikeway length | - | - | - |
| Distance*Pop density | - | - | - |
| Distance*Job density | + | + | + |
| Distance* % recreation | - | - | - |
| Distance*% retail | - | - | - |
| Distance*% office | + | - | + |
| Distance*% industrial | - | - | - |
| Prob.>Chi2 | 0 | 0 | 0 |
| Log Likelihood | -738111.14 | -421262.79 | -316204.62 |

# *Practical implications – Exploratory Analysis*

- One member lives close to uptown and the distance to nearest bike station is about 0.30 miles. Based on our models, current weekly use frequency is about 1.13 times to use bike share

| | Model 1 | |
|---|---|---|
| | Scenario 1 | Scenario 2 |
| Interventions | Install a new station to decrease the distance from 0.30 mile to 0.12 mile | Scenario1 + add 0.12 mile (200 meter) bike facilities within quarter miles |
| Weekly use frequency | 1.13 →1.15 | 1.13 →2.0 |

# Findings

## Research Question 1

- How does improvement of accessibility to bike share stations influence frequency of use by annual members? (Causality)
  - Accessibility to bike share station +

## Research Question 2

- How do impacts of accessibility differ in different contexts, specifically, in relation to different features of the built environment settings?
  - Bike facility ↗
  - Higher population density, higher percentage of recreation, retail land use and industrial land use ↗

# *Implications*

| Findings | Implications |
| --- | --- |
| • Accessibility to Bike Share Stations: + | • Prioritize to place Nice Ride stations in the area with concentrated current users and bike facilities |
| • Bike facility: ↗ | • New bike facility investment |
| • Higher population density, higher percentage of recreation, retail land use and industrial land use : ↗ | • Place a Nice Ride station in the area |

# Limitations & Future Research

**Exogenous of bike share station location choices?**

**Measurement of accessibility**

**Likelihood of being bike share members**

# *Implications*

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