The Effects of Bike Share on Transit Ridership

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TRANSIT, DEVELOPMENT AND FORME URBAINE: WASHINGTON ET PARIS
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The Idea
• Understand the spatial patterns of bikeshare programs
• Understand the changing spatial patterns overtime
• Understand the impacts of bikeshare programs on transit ridership
Questions We Ask

• Is there a relationship between the spatial pattern of bicycle sharing trips and the rail transit station location?

• Does the existence of bicycle sharing station in the vicinity of a rail station help increase transit ridership?
Two-part analysis

• Spatial examination
  – Origin – Destination (O - D) analysis
    • by year
    • by season

• Econometric examination
  – OLS regression analysis
    • Bikeshare station features
    • Transit characteristics
    • Built environments
    • Socio-demographics
Capital Bicycle (CaBi) sharing in D.C.

- Established in September 2010
- 321 stations, 2,500 bicycles, 22,200 members (as of July 2014)
- Users’ profile:
  - 63%: under 35
  - 57%: male
  - 80%: white
  - 95%: have a four-year college degree
  - 52%: found bikesharing helpful at reducing their transportation cost as well as pollution

(source: 2013 Capital Bikeshare Member Survey Report)
Origin-Destination (O-D) Analysis
----by year

Number of trips by O-D pair
- 100 - 500
- 501 - 1,000
- 1,000 +
- Metrorail Stations

2011 Quarter 3
2012 Quarter 3
2013 Quarter 3
By year:
• In 2011 – 2013, the increase in bicycle share program over three years as well as the increase in number of trips
• CaBi stations with highest ridership share similar built environments
  – Woodley park zoo
  – Dupont Circle
  – Union Station
  – Easton Market
  – Tidal Basin
  – Crystal City
  – Court House
• Co-location of CaBi and metro rail stations
• Most commuting trips are shorter than other modes
By season:

- 2\textsuperscript{nd} and 3\textsuperscript{rd} quarter have the highest ridership
  - Tourist
  - Outdoor activities

- Despite the seasonal change, two stations have the highest ridership throughout the year:
  - Dupont Circle
  - Capitol Hill

- Some exceptions:
  - Students
## DATA CATEGORY AND SOURCES

<table>
<thead>
<tr>
<th>Category</th>
<th>Variables</th>
<th>Description</th>
<th>Data source</th>
<th>Geography</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transit service</strong></td>
<td>Average Daily boardings of walks or bikes to different access modes</td>
<td>WMATA, 2013</td>
<td>station</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transit ridership 2013</td>
<td>WMATA, 2013</td>
<td>station</td>
<td></td>
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<tr>
<td></td>
<td>Parks and ride</td>
<td>WMATA, 2013</td>
<td>station</td>
<td></td>
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<td></td>
<td>Parking Space</td>
<td>WMATA, 2013</td>
<td>station</td>
<td></td>
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<td></td>
<td>Bus Stops</td>
<td>OTFS, 2014</td>
<td>location</td>
<td></td>
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<tr>
<td></td>
<td>TPZ Peaks</td>
<td>WMATA, 2013</td>
<td>station</td>
<td></td>
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<tr>
<td></td>
<td>Terminal</td>
<td>WMATA, 2013</td>
<td>station</td>
<td></td>
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<tr>
<td></td>
<td>Transit connectivity</td>
<td>NCSG 2010 (14)</td>
<td>station</td>
<td></td>
</tr>
<tr>
<td><strong>Bike sharing Program</strong></td>
<td>Number of Citi bike stops in transit catchment area</td>
<td>DDOT, 2013</td>
<td>location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bike ridership</td>
<td>Capital Bikeshare and DDOT, 2013</td>
<td>location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B11</td>
<td>1, transit station has Citi bike station; 0, otherwise</td>
<td>DDOT, 2013</td>
<td>location</td>
</tr>
<tr>
<td><strong>Density</strong></td>
<td>Residential density, Population density, employment density</td>
<td>SLD, 2012</td>
<td>Block group</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Employment mix index</td>
<td>SLD, 2012</td>
<td>Block group</td>
<td></td>
</tr>
<tr>
<td><strong>Station built environment</strong></td>
<td>Number of intersections around station</td>
<td>OSIM, 2013</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gini index</td>
<td>OSIM, 2013</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of jobs that can be accessed within 30 minutes by auto or 60 minutes by transit</td>
<td>NCSG, 2012</td>
<td>Station</td>
<td></td>
</tr>
</tbody>
</table>

**Sociodemographics (0.5-mile buffer)**

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<th>Geography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pwhite</td>
<td>Percent of white population of the block group that Metro Park station is located</td>
<td>ACS, 2007-2011</td>
<td>Block group</td>
</tr>
<tr>
<td>PHispanic</td>
<td>Percent of Hispanic population of the block group that Metro Park station is located</td>
<td>ACS, 2007-2011</td>
<td>Block group</td>
</tr>
<tr>
<td>Ppoverty</td>
<td>Percent of household under poverty</td>
<td>ACS, 2007-2011</td>
<td>Block group</td>
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<tr>
<td>Median Income</td>
<td>Median income of the block group in which Metro Park station is located</td>
<td>ACS, 2007-2011</td>
<td>Block group</td>
</tr>
<tr>
<td>Pct_Lao0</td>
<td>Percent of household without a vehicle</td>
<td>SLD, 2012</td>
<td>Block group</td>
</tr>
<tr>
<td>householdsQ</td>
<td>Number of households in transit catchment area</td>
<td>ACS, 2007-2011</td>
<td>Census tract</td>
</tr>
</tbody>
</table>
• **Transit Service Variables**
  – Transit ridership
  – Parking
  – bus connection
  – transit frequency
  – transit connectivity

• **Bicycle Sharing Program Variables**
  – Station location
  – # of CaBi stations within metro rail station areas
  – CaBi station ridership

• **Built Environment Variables**
  – Density (employment, population, household)
  – Diversity (employment mix)
  – Design (street network density)
  – job accessibility

• **Socio-demographic Variables**
  – income
  – Racial composition
  – Car ownership
  – Poverty
## OLS regression analysis

LogTransitRidership2013

<table>
<thead>
<tr>
<th></th>
<th>Model 1: Full model</th>
<th></th>
<th>Model 2: Parsimonious model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.39</td>
<td>1.0</td>
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<tr>
<td>logBR2013</td>
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<td>logtransitConnectivity</td>
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<td>0.09</td>
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<td>logTPHPeak</td>
<td>0.49</td>
<td>0.20</td>
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<td>0.49</td>
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<tr>
<td>logHouseholds000025miles</td>
<td>0.03</td>
<td>0.08</td>
<td>0.69</td>
<td>-</td>
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<tr>
<td>Logempden</td>
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<td>0.06</td>
<td><strong>0.018</strong></td>
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<td>logBusStops</td>
<td>0.21</td>
<td>0.12</td>
<td><strong>0.096</strong></td>
<td>0.20</td>
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<td>logIntersectionQ</td>
<td>-0.12</td>
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<td>0.301</td>
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<tr>
<td>logmedianincome</td>
<td>0.041</td>
<td>0.01</td>
<td><strong>0.003</strong></td>
<td>0.04</td>
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<tr>
<td>Adjusted R²</td>
<td><strong>0.81</strong></td>
<td></td>
<td></td>
<td><strong>0.82</strong></td>
</tr>
</tbody>
</table>
OLS regression analysis results

- 10% increase in bicycle sharing ridership will lead to 2.8% increase in transit ridership
- Employment concentration at the transit station areas has even stronger impacts on transit ridership than residential concentration
- 10% increases in transit frequency will lead to 4.9% increase in transit boardings
- Bus connection are also important to provide egress and access connection
Discussions

• Spatial patterns of bikeshare stations in both urban and suburban areas
  – Denser, mixed land use, vibrant historic districts
  – Closer to rail transit

• The close interactions between bikeshare program and rail transit
  – Higher bike ridership, higher transit ridership

• Impacts of bikeshare on transit or vice versa?
Future research

- Endogeneity
- Self-selection
- Time-series
Thanks!

Q&A