Moving Toward Equitable Transit-Oriented Developments by Integrating Transit and Housing

Hongwei Dong

California State University, Fresno

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Moving Toward Equitable Transit-Oriented Development by Integrating Transit and Housing

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Friday Transportation Seminar
Transportation Research and Education Center (TREC) @ Portland State University
April 10, 2020 (Webinar)

This study is preliminary and has not been peer-reviewed. Please do NOT cite.
About Myself

• **Associate Professor**
  • Department of Geography and Planning at California State University Fresno (2011-present)
  • Research interests: housing and real estate, transportation and land use, & healthy cities

• **Ph.D. in Urban Studies from the Toulan School at PSU (2005-10)**
  • Selected my research area after attending a Friday Transportation Seminar talk by Brian Gregor (ODOT research staff) in 2008
  • Dissertation: developed a housing supply model to test Portland's smart growth policies (Part of a larger Integrated Transportation and Land Use Forecast Model)
About Myself

- Maintained my interest in Portland’s urban growth and housing market while working in California
My research on Portland’s TOD and Gentrification


  - A longitudinal quasi-experimental design to examine five rail transit lines in suburban Portland and gentrification.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Number of suburban neighborhoods served by rail transit in Portland.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastside</td>
<td>1986</td>
</tr>
<tr>
<td>Westside</td>
<td>1998</td>
</tr>
<tr>
<td>Airport</td>
<td>2001</td>
</tr>
<tr>
<td>Interstate</td>
<td>2004</td>
</tr>
<tr>
<td>I-205</td>
<td>2009</td>
</tr>
<tr>
<td>WES</td>
<td>2009</td>
</tr>
</tbody>
</table>

Note: Streetcar and the transit mall opened in 2000 are not considered because they mainly serve downtown Portland.
My research on Portland’s TOD and Gentrification

- Major findings from this study
  - No consistent evidence for rail-transit-induced gentrification in suburban Portland.
  - No evidence that rail transit reduced home affordability.
  - More changes in the neighborhoods served by the Eastside line (the oldest)
    - Attracted older and less-educated population
    - Experienced densification and faster increases of the share of rental units
  - Rail transit was more likely to be installed along low-income suburban neighborhoods.
Outline

1. Background & Literature
2. Research Question & Study Area
3. Data, Measurement, & Method
4. Analysis
5. Finding
6. Conclusion
Background: TOD

- Transit-oriented development (TOD)
  - Centered on transit (mainly rail transit)
  - Walkable and compact neighborhoods
    - Higher density
    - Mixed land use
    - Walkability

Background: Connecting Transit with Housing

- Alleviate California’s housing affordability crisis via TOD?
- Proposed SB50: upzoning near transit and jobs
  - Cities required to allow apartment buildings:
    - within a 1/2-mile of a rail transit station;
    - within a 1/4-mile of a high-frequency bus stop; or
    - within a “job-rich” neighborhood.
  - Upzone to allow buildings to be 45/55 feet tall
  - Reduce parking requirement significantly

Senator Wiener Introduces Zoning Reform Bill to Allow More Housing Near Public Transportation and Job Centers

Background: Connecting Transit with Housing

- SB50 has been very controversial
  - Wealthy home owners: NIYMBY
  - Low-income tenants: gentrification


The Last Days of SB50, California’s Doomed Upzoning Bill

Senate Bill 50, the transit-housing legislation championed as a market-based response to the affordability crisis, will not become law.

A controversial bill promoting higher-density housing near transit stops was defeated in a vote by California’s state senate on Thursday. State Bill 50—whose multi-year journey through the state’s lawmaking machinery has been closely watched by housing and transit advocates nationwide—fell three votes short of heading to the desk of Governor Gavin Newsom.


Efforts to build housing around transit threaten to price out those most dependent on bus and rail

Inside two hours, six people overdosed in four San Diego incidents. Three died. Fentanyl played a role in at least three of Tuesday’s incidents.

April 3, 2018

Woman, 62, dies after her SUV rolls over her in San Diego

Police said the driver apparently failed to shift her Toyota Highlander all the way into park Friday morning, along Carmel Valley Road.

April 5, 2018

Literature: Connecting Transit with Housing

- Property-value effects of rail transit
  - A well studied topic: housing transaction data are readily available
  - Majority of studies found significant and positive impacts
    - Benefit property owners
    - Justify the high cost of rail transit
      - Greater property tax base
      - More tax revenues for local governments
Literature: Connecting Transit with Housing

- How about renters? Do they benefit from TOD?
  - A understudied topic: rent data are harder to obtain
  - Equity implications:
    - TOD premium is a burden instead of a benefit
    - Renters have lower income and more housing-burdened
    - Gentrification and displacement
Research Question

- Today’s presentation focuses on the impacts of TOD on rents
- **Question 1:** How much more do Californian renters have to pay to live in TODs?
- **Question 2:** Does TOD rent premium vary:
  - Renters in different metro areas in California
  - Different dwelling sizes (studio, 1 bedroom, 2 bedroom, 3+ bedroom)
  - Different TOD types (urban TOD, suburban TOD, & TAD)
Study Area

- Rail transit stations in eight Californian metropolitan areas
  - 708 rail transit stations
    - Removed two funicular stations and 12 airport rail link stations
  - Use 694 rail transit stations for this analysis
    - San Francisco: 281
    - Los Angeles: 148
    - San Diego: 83
    - San Jose: 84
    - Sacramento: 54
    - Riverside (Inland Empire): 33
    - Santa Rosa (Sonoma County): 6
    - Oxnard (Ventura County): 5
Data & Measurement

- Data sources
  - Rent: Craigslist.com
  - Rail transit: Transit Explorer 2 (thetransportpolitic.com)
  - Neighborhood social & built environments:
    - American Community Survey (ACS) 2014-18
    - Longitudinal Employer-Household Dynamics (LEHD 2017)
  - Boundary and road: Census TIGER
Data & Measurement

- Craigslist rent data:
  - Scraped 12/27/2019 – 01/31/2020
  - Non-traditional data: may not be representative
    - Over-represent whiter, wealthier, and better-educated communities/groups
- Advantages of Craigslist data
  - Crowd-sourced: comprehensive, large & free
  - More current than traditional data set (ACS & AHS)
  - Available at fine spatial scale (point level)
  - Richer information about the spot market

Data & Measurement

- Craigslist rent data are messy
  - Many duplicates
    - Landlords re-post/update their listings every few days to maintain visibility
  - Inaccurate/incomplete addresses information

- Data cleaning is very time-consuming and tedious
  - 80% time on data cleaning & 20% time on data analysis

- This analysis
  - 370,013 listings scraped
  - 73,775 used for analysis
Data & Measurement

- Median rent: Craigslist over-represents higher-end rental units

<table>
<thead>
<tr>
<th>Metro</th>
<th>Craigslist Jan. 2020</th>
<th>ACS 2014-18</th>
<th>AHS 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>$2,850</td>
<td>$1,687</td>
<td>$1,900</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>$2,160</td>
<td>$1,363</td>
<td>$1,400</td>
</tr>
<tr>
<td>San Diego</td>
<td>$2,020</td>
<td>$1,465</td>
<td>n.a.</td>
</tr>
<tr>
<td>San Jose</td>
<td>$2,850</td>
<td>$1,996</td>
<td>$2,200</td>
</tr>
<tr>
<td>Sacramento</td>
<td>$1,599</td>
<td>$1,084</td>
<td>n.a.</td>
</tr>
<tr>
<td>Riverside</td>
<td>$1,652</td>
<td>$1,119</td>
<td>$1,100</td>
</tr>
<tr>
<td>Oxnard</td>
<td>$2,150</td>
<td>$1,595</td>
<td>n.a.</td>
</tr>
<tr>
<td>Santa Rosa</td>
<td>$2,227</td>
<td>$1,412</td>
<td>n.a.</td>
</tr>
</tbody>
</table>
Data & Measurement

- **Dwelling size:** Craigslist over-represents units with one-bedroom but under-represents units with 3+ bedrooms

<table>
<thead>
<tr>
<th>Metro</th>
<th>Size</th>
<th>Craigslist (%)</th>
<th>ACS 2014-18 (%)</th>
<th>AHS 2017 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>studio</td>
<td>10.0</td>
<td>11.7</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>1 bedroom</td>
<td>39.1</td>
<td>30.7</td>
<td>34.8</td>
</tr>
<tr>
<td></td>
<td>2 bedrooms</td>
<td>35.3</td>
<td>34.7</td>
<td>35.6</td>
</tr>
<tr>
<td></td>
<td>3+ bedrooms</td>
<td>15.6</td>
<td>22.9</td>
<td>22.4</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>studio</td>
<td>10.6</td>
<td>10.2</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td>1 bedroom</td>
<td>39.4</td>
<td>31.1</td>
<td>35.8</td>
</tr>
<tr>
<td></td>
<td>2 bedrooms</td>
<td>37.8</td>
<td>38.3</td>
<td>39.2</td>
</tr>
<tr>
<td></td>
<td>3+ bedrooms</td>
<td>12.2</td>
<td>20.5</td>
<td>19.5</td>
</tr>
<tr>
<td>San Jose</td>
<td>studio</td>
<td>6.0</td>
<td>7.8</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>1 bedroom</td>
<td>37.8</td>
<td>27.7</td>
<td>31.0</td>
</tr>
<tr>
<td></td>
<td>2 bedrooms</td>
<td>39.6</td>
<td>37.5</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td>3+ bedrooms</td>
<td>16.6</td>
<td>27.1</td>
<td>28.5</td>
</tr>
<tr>
<td>Sacramento</td>
<td>studio</td>
<td>3.4</td>
<td>4.2</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>1 bedroom</td>
<td>29.0</td>
<td>22.8</td>
<td>16.9</td>
</tr>
<tr>
<td></td>
<td>2 bedrooms</td>
<td>40.8</td>
<td>38.0</td>
<td>40.9</td>
</tr>
<tr>
<td></td>
<td>3+ bedrooms</td>
<td>26.8</td>
<td>35.0</td>
<td>41.1</td>
</tr>
<tr>
<td>San Diego</td>
<td>studio</td>
<td>6.3</td>
<td>6.1</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>1 bedroom</td>
<td>32.5</td>
<td>25.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 bedrooms</td>
<td>43.4</td>
<td>42.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3+ bedrooms</td>
<td>17.8</td>
<td>26.8</td>
<td></td>
</tr>
</tbody>
</table>
Neighborhood: Craigslist listings tend to be in neighborhoods with more jobs, newer homes, Whites & Asians, and higher income.
Data & Measurement

- Measuring TOD: within 0.5-mile street network distance
  - TOD (treated) units: rental units within 0-0.5 mile (yellow area)
  - Non-TOD (control) units: rental units > 1.0 mile (outside of blue area)
Method: Why Use PSM?

- Three potential approaches to tease out the effect of TOD on rents
  - OLS hedonic model does not address two critical issues
    - Spatial autocorrelation
    - Self-selection
  - Spatial regression model (spatial lag, spatial error, & Durbin/mixed)
    - Assumes the spatial relationship is known
    - Does not address the self-selection problem
  - Propensity score matching (PSM)
I adopt the propensity score matching (PSM) method.

- Rental units in TODs (within 0.5-mile network distance)
- Rental units in transition area (within 0.5-1.0 mile network distance)
- Rental units not in TODs (> 1.0-mile network distance)

PSM

- Similar housing attributes
- Similar neighborhood environment
- Similar location

Rental units in TODs (treatment)

Price difference (average treatment effect)

Rental units not in TODs (control)
Method: Why Use PSM?

- Why use propensity score matching (PSM)?
  - Address the self-selection bias by identifying a control group
  - Spatial autocorrelation is not a concern
  - Study design is determined before analysis, like randomized controlled trial
Method: PSM

- PSM: allow replacement or not?
  - Without replacement:
    - One untreated case can be used only *once* as a control case
    - Higher-quality matching but some treated cases may not be matched
  - With replacement:
    - One untreated case can be used as a control for *multiple* treated cases
    - Lower-quality matching but almost all treated cases can be matched
Analysis: Identify Control Cases

- In the following, I will report the results from PSM *without* replacement because of their higher quality of matching.
- Not every TOD rental unit can be matched with a control unit when replacement is not allowed.

<table>
<thead>
<tr>
<th></th>
<th>Matched without replacement</th>
<th>Matched with replacement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treated</td>
<td>Control</td>
</tr>
<tr>
<td>All</td>
<td>12,863</td>
<td>28,134</td>
</tr>
<tr>
<td>Matched</td>
<td>7,446</td>
<td>7,446</td>
</tr>
<tr>
<td>Unmatched</td>
<td>5,417</td>
<td>30,688</td>
</tr>
</tbody>
</table>

Treated = TOD rental units; control = non-TOD rental units
Method: PSM

- Control variables (covariates in PSM)
  - Housing attributes (bedroom, bathroom, building structure)
  - Neighborhood environment
    - Land use: activity density (pop. & job) & mixed land-use
    - Housing stock: shares of rental units, share of single-family homes, & age (new homes built since 2000, & old homes built before 1940)
    - Social environment: median household income & shares of Black and Hispanic pop.
  - Location: distance to CBD & specific metropolitan area
Method: PSM

- Balance diagnostics: how similar are treatment and control groups?
  - **Paired t-tests**: compare their mean values
    - Widely used in literature
    - Problem: sensitive to sample size (larger sample size becomes a “disadvantage”?)
  - **Standardized difference** (Austin 2011)
    - Not sensitive to sample size
    - Standardized difference <0.1 indicates negligible difference
  - **Variance ratio**: compare distribution (Austin 2011)

## Analysis: Identify Control Cases

- The covariates of the treatment and control groups (7,446 pairs) are well balanced

<table>
<thead>
<tr>
<th></th>
<th>Mean value: TOD units</th>
<th>Mean value: non-TOD units</th>
<th>Mean difference</th>
<th>Standardized mean difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedroom</td>
<td>1.50</td>
<td>1.51</td>
<td>-0.01</td>
<td>-0.011</td>
</tr>
<tr>
<td>Bathroom</td>
<td>1.36</td>
<td>1.36</td>
<td>-0.01</td>
<td>-0.019</td>
</tr>
<tr>
<td>Neighborhood environment: Activity density (pops &amp; jobs per acre)</td>
<td>41.22</td>
<td>38.50</td>
<td>2.72</td>
<td>0.002</td>
</tr>
<tr>
<td>Mixed land use</td>
<td>0.33</td>
<td>0.32</td>
<td>0.01</td>
<td>0.022</td>
</tr>
<tr>
<td>Median household income ($1000)</td>
<td>77.50</td>
<td>77.86</td>
<td>-0.36</td>
<td>0.000</td>
</tr>
<tr>
<td>Share of Black pop. (%)</td>
<td>6.46</td>
<td>6.32</td>
<td>0.15</td>
<td>0.002</td>
</tr>
<tr>
<td>Share of Hispanic pop. (%)</td>
<td>27.64</td>
<td>27.41</td>
<td>0.23</td>
<td>0.000</td>
</tr>
<tr>
<td>Neighborhood housing stock: Share of SFHs (%)</td>
<td>26.52</td>
<td>28.31</td>
<td>-1.79</td>
<td>-0.003</td>
</tr>
<tr>
<td>Share of rental housing (%)</td>
<td>74.55</td>
<td>72.97</td>
<td>1.58</td>
<td>0.004</td>
</tr>
<tr>
<td>Share of housing built since 2000 (%)</td>
<td>20.86</td>
<td>22.06</td>
<td>-1.20</td>
<td>-0.002</td>
</tr>
<tr>
<td>Share of housing built before 1940 (%)</td>
<td>16.59</td>
<td>14.84</td>
<td>1.75</td>
<td>0.004</td>
</tr>
<tr>
<td>Location: distance to CBD</td>
<td>10.96</td>
<td>11.71</td>
<td>-0.74</td>
<td>-0.008</td>
</tr>
<tr>
<td>In Los Angeles (yes=1)</td>
<td>0.33</td>
<td>0.34</td>
<td>0.00</td>
<td>-0.009</td>
</tr>
<tr>
<td>In San Francisco (yes=1)</td>
<td>0.25</td>
<td>0.23</td>
<td>0.02</td>
<td>0.048</td>
</tr>
<tr>
<td>In San Jose (yes=1)</td>
<td>0.11</td>
<td>0.10</td>
<td>0.01</td>
<td>0.042</td>
</tr>
<tr>
<td>In San Diego (yes=1)</td>
<td>0.17</td>
<td>0.20</td>
<td>-0.02</td>
<td>-0.061</td>
</tr>
<tr>
<td>In Sacramento (yes=1)</td>
<td>0.08</td>
<td>0.07</td>
<td>0.01</td>
<td>0.022</td>
</tr>
</tbody>
</table>
Analysis: Identify Control Cases

- What types of TOD units were not matched when replacement is not allowed?
  - In neighborhoods with higher levels of density and mixed use
  - In neighborhoods with newer and older housing
  - Closer to CBD
  - In San Francisco
Finding: TOD Rent Premium in CA

- TOD premium in California: $127

<table>
<thead>
<tr>
<th></th>
<th>Matched without replacement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TOD units (treated)</td>
</tr>
<tr>
<td>N</td>
<td>7,446</td>
</tr>
<tr>
<td>Mean monthly rent</td>
<td>$2,545</td>
</tr>
<tr>
<td>TOD premium</td>
<td>$127** (5.3%)</td>
</tr>
</tbody>
</table>

**Statistically significant at the 1% level**
Finding: TOD Rent Premium by Dwelling Size

- TOD premiums are higher for rental units of larger sizes
  - Studio 4.6%; 1-bedroom: 4.0%; 2-bedroom: 6.8%; 3-bedroom: 7.6%
Finding: TOD Rent Premium by TOD Types

- Group 694 rail transit stations into 3 clusters (via cluster analysis)
  - Urban TOD,
  - Suburban TOD, &
  - TAD (transit-adjacent development)

<table>
<thead>
<tr>
<th></th>
<th>Urban TOD (N=134)</th>
<th>Suburban TOD (N=339)</th>
<th>TAD (N=221)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to CBD (mile)</td>
<td>1.5</td>
<td>6.4</td>
<td>16.1</td>
</tr>
<tr>
<td>Population density (persons/acre)</td>
<td>54.9</td>
<td>19.8</td>
<td>7.1</td>
</tr>
<tr>
<td>Job density (jobs/acre)</td>
<td>120.5</td>
<td>15.7</td>
<td>8.7</td>
</tr>
<tr>
<td>Street density (mile/acre)</td>
<td>0.038</td>
<td>0.029</td>
<td>0.019</td>
</tr>
<tr>
<td>Service area (acre)</td>
<td>432.5</td>
<td>370.3</td>
<td>228.7</td>
</tr>
<tr>
<td>Metro areas:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bay Area</td>
<td>79.9%</td>
<td>58.1%</td>
<td>30.3%</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>7.5%</td>
<td>29.2%</td>
<td>34.8%</td>
</tr>
<tr>
<td>Sacramento</td>
<td>9.7%</td>
<td>4.1%</td>
<td>12.2%</td>
</tr>
<tr>
<td>San Diego</td>
<td>3.0%</td>
<td>8.6%</td>
<td>22.6%</td>
</tr>
<tr>
<td>Total</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Finding: TOD Rent Premium by TOD Types

- TOD premiums for three types of TODs
  - Suburban TOD > Urban TOD
  - Even TAD generates some premium

<table>
<thead>
<tr>
<th>TOD Type</th>
<th>Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban TOD</td>
<td>$128</td>
</tr>
<tr>
<td>Suburban TOD</td>
<td>$153</td>
</tr>
<tr>
<td>TAD</td>
<td>$76</td>
</tr>
</tbody>
</table>
Finding: TOD Rent Premium in Metro Areas

- TOD rent premium in three major regions:
  - LA: none; Bay area: 7.0%; & San Diego: 8.2%.

*TOD premium in the greater LA region is not statistically different from zero*
Caveat

- Cross-sectional data
- Craigslist data over-represent higher-end rental units in well-off neighborhoods
- Hard to find matches/control cases for TOD rental units that are:
  - Small-sized (studios & 1-bedroom)
  - Located in central-city neighborhoods, particularly those in San Francisco
- TOD premium is less certain for central-urban rental units
  - This is a hidden (but important) issue when running a hedonic regression
Conclusion

- Craigslist data are very useful
  - Until local governments systematically collect rent data and make them public (like what they do with housing transaction data)
  - Portland to require landlords to register rental properties to the city by 2020
- PSM shows advantages over and more transparency than the hedonic regression method
Conclusion

- The average TOD rent premium is $127
  - About 5.3% of average rent in TODs
- TOD rent premium is greater for larger rental units in absolute value and in percentage
- TOD rent premium varies in different metro areas
  - None in LA and around 7.0% in the Bay area, and 8.2% in San Diego
- Suburban TOD rent premium is greater than urban TOD rent premium
Conclusion

- TOD & gentrification
  - The threat of gentrification is real, at least in the Bay area and San Diego
  - TOD rent premium could worsen the housing affordability crisis
  - However, the overall effect depends on how much renters could save on transportation expenditures

- Equity implications
  - Renters vs. homeowners
    - Renters are in a more disadvantaged position, compared to homeowners
  - A windfall for landlords/housing investors
    - They may have to pay higher property taxes. Is this enough?
    - We may need better value-capture mechanisms
Conclusion

- Next step:
  - Estimate the transportation cost saving effects of TOD
  - Compare TOD rent premium with transportation cost savings

*Travel time cost is not considered.*