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This study is preliminary and has not been peer-reviewed. Please do NOT cite.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>Rail transit lines open before 2010</th>
<th>Open</th>
<th># of suburban neighborhoods served (in Census years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastside</td>
<td>1986</td>
<td>58, 0, 39, 30, 35</td>
</tr>
<tr>
<td>Westside</td>
<td>1998</td>
<td>0, 30</td>
</tr>
<tr>
<td>Airport</td>
<td>2001</td>
<td>0, 30</td>
</tr>
<tr>
<td>Interstate</td>
<td>2004</td>
<td>0, 30</td>
</tr>
<tr>
<td>I-205</td>
<td>2009</td>
<td>0, 35</td>
</tr>
<tr>
<td>WES</td>
<td>2009</td>
<td>0, 35</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


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

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
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)
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.
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></td>
<td></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:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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

Not-matched vs. matched TOD units
(X = not-matched/matched - 1)

- Matched TOD units demonstrate greater values
- Not-matched TOD units demonstrate greater values
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><strong>$127</strong> (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%

<table>
<thead>
<tr>
<th>Dwelling Size</th>
<th>TOD Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studio</td>
<td>$85</td>
</tr>
<tr>
<td>1-bedroom</td>
<td>$86</td>
</tr>
<tr>
<td>2-bedroom</td>
<td>$180</td>
</tr>
<tr>
<td>3+ bedroom</td>
<td>$242</td>
</tr>
</tbody>
</table>

(TOD premium (Estimated by PSM without replacement))
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

![TOD premium chart](image-url)

**TOD premium**
*(Estimated by PSM without replacement)*

- **URBAN TOD**: $128
- **SUBURBAN TOD**: $153
- **TAD**: $76
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.