The Impact of Land Use on Commute Behavior Changes: An Empirical Investigation from Northern California

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Outline

• Introduction – Questions of Interest
• Sampling and survey
• Baseline characteristics
• Descriptive statistics of commute changes
• Modeling permanent and temporary commute changes
• Conclusions
Questions of Interest

Over a 6-month period, compared to normal commute patterns, how many people made changes that were
- Permanent?
- Temporary?
- Environmentally beneficial?
- Environmentally problematic?

What factors are involved in the individual’s choice to make those changes?
- Socio-demographic data and work-related information?
- Neighborhood types and baseline commute patterns?
- Attitudes e.g. time- and price-sensitivity, environmental beliefs, and stated preference for various modes of travel?
Changes of Interest

Increases and Decreases in Drive Alone Commuting
Study Region and Context

Sacramento area, during and following the closure and (re)construction of Interstate 5
Panel Survey

Two waves of data collection during the construction – overlapping sample
Sampling Methodology

- Population of Interest:
  - Workers living somewhere in the region, for whom it was reasonable to expect that they could have been affected by the closure.

- Obtained respondents via email invitations to organizations:
  - Numerous State agencies
  - The Fix I-5 listserv (6K subscribers)
  - Transportation Management Agencies (TMAs)
  - The Commuter Club of the Sacramento TMA (25K subscribers)
Wave 3: six months later

- In January/February 2009, re-surveyed Wave 1 & 2 respondents who had given us permission to do so
- Obtained ~2000 usable responses
- Individuals in the final sample completed the wave 1 or wave 2 survey or both (with preference given to wave 2 in this study), and completed the wave 3 survey
Wave 1 and 2 Survey

- Four parts in each survey (Wave 1 and Wave 2 nearly identical):
  - Part A: “normal” (pre-Fix) work and commute patterns
  - Part B: travel changes made during the target week
  - Part C: commute-related programs, possible facilitators/barriers to changing commuting habits, and sources of information on Fix I-5
  - Part D: socio-demographic characteristics
Wave 3 Survey

- Six sections in the Wave 3 Survey:
  - Part A: attitudes, lifestyle, values/beliefs
  - Part B: current baseline work and commute patterns
  - Part C: permanent changes made to work/commute patterns since spring 2008
  - Part D: temporary changes made to work/commute patterns during summer 2008
  - Part E: desirability of sustainable commute actions, and barriers to them
  - Part F: socio-demographic characteristics
Key Assumptions

- Individuals’ attitudes in wave 3 represent attitudes over the study period.
- When individuals responded to both waves 1 and 2, changes made during wave 2 were considered.
- Individuals who are already performing certain behaviors can not switch to that behavior.
- Drive alone commuting is most problematic in terms of greenhouse gas emissions.
In all waves of the survey, we asked the current frequency with which respondents:

- Worked at home without commuting (home-based business or telecommuting)
- Physically commuted, and;
- Rode a bus for any portion of the commute
- Rode light rail for any portion of the commute
- Rode Amtrak for any portion of the commute
- Rode a bicycle for any portion of the commute
- Car/vanpooled for most of the commute
- Drove alone for most of the commute
- Walked for the entire commute
Identifying Changes

- **Permanent Changes**
  - Compare frequencies of drive alone commuting between waves 1-2 and wave 3
  - Identify self-reported permanent changes in driving alone, reported in wave 3

- **Temporary Changes**
  - Identify contemporaneous changes reported in waves 1 and 2
  - Identify retrospective changes reported in wave 3
Frequencies of Changes

Total Sample = 2012

- Neither Change (1227) 61%
- Change (785) 39%
- Decrease Only (329) 16%
- Increase Only (346) 17%
- Combinations (110) 6%
Frequencies of Changes

Increases (N = 456)
Total Permanent Increases = 379
Total Temporary Increases = 77

Decreases (N = 439)
Total Permanent Decreases = 229
Total Temporary Decreases = 210

Total Permanent Increases = 379
Total Temporary Increases = 77

Total Permanent Decreases = 229
Total Temporary Decreases = 210
Modeling Changes

- What factors (demographics, commute patterns and attitudes) influence individuals to make increases and decreases in driving alone?
- Are the same factors important for permanent and temporary changes?
- Did Fix I-5 play a role in the propensity to make these changes?
- Are land use characteristics important factors in whether or not individuals made changes?
Demographics

- 64% of the sample is female, 36% male
- 65% has completed 4-year degree or higher level of education
- 80% has annual income of ≥ $60,000

Average household:
- Size is 2.7 persons
- Number of motorized vehicles is 2.2
- Is within a 10-minute walk of transit (58.7% of sample)
- Has approximately 0.5 children
- Has approximately 2.10 licensed drivers
- Has 1.9 workers (full and part time)
## Commute Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total Sample</th>
<th>Permanent Increase (N=379)</th>
<th>Temporary Increase (N=77)</th>
<th>Permanent Decrease (N=229)</th>
<th>Temporary Decrease (N=210)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commute Minutes (1965)</td>
<td>33.98</td>
<td>30.5</td>
<td>32.01</td>
<td>33.71</td>
<td>33.17</td>
</tr>
<tr>
<td>Commute Distance (1957)</td>
<td>18.05</td>
<td>17.3</td>
<td>15.65</td>
<td>16.31**</td>
<td>19.60**</td>
</tr>
<tr>
<td>Household Vehicles (1913)</td>
<td>2.21</td>
<td>2.10</td>
<td>2.3</td>
<td>2.44*</td>
<td>2.28*</td>
</tr>
</tbody>
</table>

1. p-values are shown for chi-square tests for significant differences among categories for permanent, temporary and no change within the same type of change. 2. * and ** represent mean values which are significantly different to the 0.1, and .05 level between the permanent and temporary changes only; not compared to those who did not change.
Mode Use by Decrease

- None
- Permanent
- Temporary

Options:
- WAH Reg.
- WAH No Chng
- WAH Chng
- WAH Instead
- Commute
- DA
- Car or Van Pool
- Bus
- Lt. Rail
- Amtrak
- Walk
- Bike
Mode Use by Increase

- None
- Permanent
- Temporary

- WAH Regular
- WAH No Change
- WAH Change
- WAH Instead
- Commute
- DA
- Car or Van Pool
- Bus
- Light Rail
- Amtrak
- Walk
- Bike
## Land Use Characteristics

<table>
<thead>
<tr>
<th>Characteristic (Self-reported)</th>
<th>Total Sample</th>
<th>Permanent Increase (N=379)</th>
<th>Temporary Increase (N=77)</th>
<th>Permanent Decrease (N=229)</th>
<th>Temporary Decrease (N=210)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type (1939)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot of Retail/Commercial</td>
<td>201 (10.4%)</td>
<td>32 (8.7%)</td>
<td>7 (9.7%)</td>
<td>24 (10.9%)</td>
<td>12 (5.8%)</td>
</tr>
<tr>
<td>Some Retail/Commercial</td>
<td>644 (33.2%)</td>
<td>117 (32.0%)</td>
<td>25 (34.7%)</td>
<td>70 (31.7%)</td>
<td>67 (32.5%)</td>
</tr>
<tr>
<td>Mostly Residential</td>
<td>964 (49.7%)</td>
<td>194 (53.0%)</td>
<td>38 (52.8%)</td>
<td>117 (52.9%)</td>
<td>114 (55.3%)</td>
</tr>
<tr>
<td>Few Other Buildings</td>
<td>89 (4.6%)</td>
<td>15 (4.1%)</td>
<td>2 (2.8%)</td>
<td>6 (2.7%)</td>
<td>10 (4.9%)</td>
</tr>
<tr>
<td>Other</td>
<td>41 (2.1%)</td>
<td>8 (2.2%)</td>
<td>0</td>
<td>4 (1.8%)</td>
<td>3 (1.5%)</td>
</tr>
<tr>
<td>Transit (1936)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 5 minute walk</td>
<td>622 (32.1%)</td>
<td>106 (29.0%)</td>
<td>30 (41.7%)</td>
<td>78 (35.3%)</td>
<td>59 (28.6%)</td>
</tr>
<tr>
<td>5-10 minute walk</td>
<td>526 (27.2%)</td>
<td>125 (34.2%)</td>
<td>18 (25.0%)</td>
<td>48 (21.7%)</td>
<td>65 (31.6%)</td>
</tr>
<tr>
<td>More than 20 minute walk</td>
<td>307 (15.9%)</td>
<td>39 (10.7%)</td>
<td>12 (16.7%)</td>
<td>41 (18.6%)</td>
<td>35 (17.0%)</td>
</tr>
<tr>
<td>Don't know</td>
<td>403 (20.8%)</td>
<td>78 (21.3%)</td>
<td>9 (12.5%)</td>
<td>43 (19.5%)</td>
<td>39 (18.9%)</td>
</tr>
<tr>
<td>Home (1936)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-Family Detached</td>
<td>1611 (83.2%)</td>
<td>308 (84.4%)</td>
<td>56 (78.9%)</td>
<td>182 (82.4%)</td>
<td>179 (87.3%)</td>
</tr>
<tr>
<td>Duplex/Town Home</td>
<td>108 (5.6%)</td>
<td>21 (5.8%)</td>
<td>3 (4.2%)</td>
<td>13 (5.9%)</td>
<td>8 (3.9%)</td>
</tr>
<tr>
<td>Apartment/Condo</td>
<td>183 (9.5%)</td>
<td>28 (7.7%)</td>
<td>11 (15.5%)</td>
<td>24 (10.9%)</td>
<td>14 (6.8%)</td>
</tr>
<tr>
<td>Other</td>
<td>34 (1.8%)</td>
<td>8 (2.2%)</td>
<td>1 (1.4%)</td>
<td>2 (0.9%)</td>
<td>4 (2.0%)</td>
</tr>
</tbody>
</table>
Factor Analysis in Wave 3

- **22 attitudinal statements**
  - 7 factors:
    - Pro-transit
    - Pro-bike/walk
    - Pro-driving
    - Pro-high-density
    - Utilitarian travel
    - Travel minimizer
    - Commute benefit
- **14 lifestyle statements**
  - 5 factors:
    - Driving commitment

- **Price sensitivity**
- **Time sensitivity**
- **Pro-exercise**
- **Variety-seeking**

- **16 values/belief statements**
  - 5 factors:
    - Congestion is a problem
    - Air quality is a problem
    - Energy dependence is bad
    - Personal responsibility
    - No worries
<table>
<thead>
<tr>
<th>Multinomial Logit Model</th>
<th>No Decrease</th>
<th>Temporary Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Alternative: Permanent Decrease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household Vehicles</td>
<td>-.22874**</td>
<td>-.51558***</td>
</tr>
<tr>
<td>Some Retail in Neighborhood</td>
<td>-.37744*</td>
<td>-.53302**</td>
</tr>
<tr>
<td>Occupation Type: Manager</td>
<td>---</td>
<td>.64983***</td>
</tr>
<tr>
<td>Occupation Type: Professional</td>
<td>-.61687***</td>
<td>---</td>
</tr>
<tr>
<td>Days Driving Alone</td>
<td>-.11439***</td>
<td>-.08366***</td>
</tr>
<tr>
<td>Days Carpooling</td>
<td>-.10589***</td>
<td>-.13257***</td>
</tr>
<tr>
<td>Days Working at Home (Changing Location)</td>
<td>-.06810***</td>
<td>---</td>
</tr>
<tr>
<td>Members of Household ages 16 to 18</td>
<td>-.34369*</td>
<td>---</td>
</tr>
<tr>
<td>Income</td>
<td>---</td>
<td>.23409**</td>
</tr>
<tr>
<td>Pro-transit attitude</td>
<td>-.17527**</td>
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<tr>
<td>Travel Minimizing Attitude</td>
<td>.22716***</td>
<td>.24547***</td>
</tr>
<tr>
<td>Commute Benefit</td>
<td>-.25106***</td>
<td>-.37418***</td>
</tr>
<tr>
<td>Anti-Driving</td>
<td>-.58563***</td>
<td>-.44067***</td>
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<tr>
<td>Price Sensitivity</td>
<td>---</td>
<td>.25669***</td>
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<tr>
<td>Constant</td>
<td>4.25597***</td>
<td>.88284</td>
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</tbody>
</table>

Note: ***, **, *: Significance at 1%, 5%, 10% level.
<table>
<thead>
<tr>
<th>Multinomial Logit Model</th>
<th>No Increase</th>
<th>Temporary Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Alternative: Permanent Increase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some Retail in Neighborhood</td>
<td>---</td>
<td>.46489*</td>
</tr>
<tr>
<td>Transit within 5 minutes</td>
<td>---</td>
<td>.48810*</td>
</tr>
<tr>
<td>Age</td>
<td>---</td>
<td>-.03401***</td>
</tr>
<tr>
<td>Days Driving Alone</td>
<td>.10258***</td>
<td>.13669***</td>
</tr>
<tr>
<td>Days Carpooling</td>
<td>.06951***</td>
<td>.13370***</td>
</tr>
<tr>
<td>Days Taking Bus</td>
<td>.06476***</td>
<td>.09381***</td>
</tr>
<tr>
<td>Days Taking Light Rail</td>
<td>.03806***</td>
<td>---</td>
</tr>
<tr>
<td>Days Taking Amtrak</td>
<td>.06035**</td>
<td>---</td>
</tr>
<tr>
<td>Days Biking</td>
<td>.05037***</td>
<td>---</td>
</tr>
<tr>
<td>Days Walking for Entire Trip</td>
<td>.15655***</td>
<td>.19308**</td>
</tr>
<tr>
<td>Commute Distance</td>
<td>---</td>
<td>-.02120*</td>
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<tr>
<td>Pro Transit Attitude</td>
<td>.22447***</td>
<td>.45093***</td>
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<tr>
<td>Price Sensitivity</td>
<td>-.21605***</td>
<td>---</td>
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<tr>
<td>Time Unpressed Lifestyle</td>
<td>---</td>
<td>-.29589**</td>
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<tr>
<td>Pro Exercise</td>
<td>---</td>
<td>.23067**</td>
</tr>
<tr>
<td>Number of Children less than Six yrs. old</td>
<td>.35671**</td>
<td>---</td>
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<tr>
<td>Part-Time Schedule</td>
<td>---</td>
<td>1.57587***</td>
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<td>Variable Schedule</td>
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<td>.93887***</td>
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<td>Normal Schedule</td>
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<tr>
<td>Constant</td>
<td>-.10783</td>
<td>-2.63605***</td>
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</tbody>
</table>

Note: ***, **, *: Significance at 1%, 5%, 10% level.
Conclusions

- Mode use in the baseline *may* be important to potential changes in driving alone.
- Attitudes are fairly good predictors of changes; particularly those related to transit and driving.
- Access to transit important for both increases and decreases in driving alone – in environmentally desirable direction.
- Land use type also important for both – again in environmentally desirable direction.
- Similar factors important for temporary and permanent changes, with more similarities between decreases in driving alone.
Future Research

- Land-use variables; home and work locations are geo-coded for finer grained analyses
- Changes in other variables; socio-demographic, employment type, self-reported land use characteristics
- What role did Fix I-5 play in changes to driving alone?
  - Particular information sources relevant for increases and decreases in driving alone?
- What factors contribute to increasing and decreasing the use other modes?
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