The impact of health conditions on senior driving: A national-level longitudinal study using the Health and Retirement Study (HRS)

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Motivation

• Is our transportation system ready to support the mobility needs of a more aged population in the future?

Preview of results

• Researchers and practitioners need a better understanding of the determinants of senior driving:
  – The impact of health on senior driving has been neglected by the transportation planning literature;

• Major findings of this study:
  – Poor general health negatively impacts senior driving (65 or older), the magnitude of the impact is larger than that of poverty status, residential patterns or family structure;
  – Impact of general health on senior driving varies by race but not by gender or poverty status;
  – Poor physical, cognitive and vision conditions negatively impact senior driving.


Projected share (%) of 65 or older in the US

<table>
<thead>
<tr>
<th>Year</th>
<th>2012</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13.7</td>
<td>16.8</td>
<td>20.3</td>
</tr>
</tbody>
</table>

Percentage of drivers (%) by age group

<table>
<thead>
<tr>
<th>Age Group</th>
<th>2012</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-59</td>
<td>93.7</td>
<td>91.4</td>
<td>83</td>
</tr>
<tr>
<td>60-69</td>
<td>91.7</td>
<td>91.4</td>
<td>83</td>
</tr>
<tr>
<td>70-79</td>
<td>91.4</td>
<td>91.4</td>
<td>83</td>
</tr>
<tr>
<td>80+</td>
<td>91.4</td>
<td>91.4</td>
<td>83</td>
</tr>
</tbody>
</table>

93.7 91.4 83 61.7
Literature

- Aging and driving (Giuliano, 2004; Rosenbloom, 2001):
  - Seniors drive considerably less after reaching age 70;
  - Seniors do not take public transportation to compensate for reduced driving.

- Insights from gerontologists:
  - Driving cessation: total discontinuation of operating a vehicle;
  - Health conditions impact driving cessation for the elderly (Anstey et al., 2006; Edwards et al., 2008);
  - Mostly from clinical trials.

Contribution

- Examining health impacts on senior driving
  - Not widely studied in the transportation planning literature;
  - Controlling for socio-demographics, residential patterns, and policy factors;

- A panel (longitudinal) dataset
  - The same respondents are surveyed across multiple time points;
  - Controlling for individual-specific unobservable factors;

- A nationally representative sample

HRS

- Health and Retirement Study (HRS) public sample
  - Bi-annual survey for persons 50 & older (1992 - 2014);
  - Nationally representative panel data (~20,000 per wave).

- Questions about driving
  - For persons 65 & older:

  - Are you able to drive?
    - Yes
    - No/have never driven

  - Have you driven a car in the past month?
    - Yes
    - No

Research design

- Why panel data?

  - Driving
  - Socio demographics etc.
  - Health conditions
  - Unobservable factors

  Respondent A, 2010
Research design

• Fixed-effects logit model:
  \[
  \text{drive}_{it} = \beta_0 + \beta_1 \text{health}_{it} + X_i' \cdot \beta_2 + \mu_i + \psi_i + \epsilon_{it}
  \]
  \[
  \Delta \text{drive}_{it} = \beta_1 \Delta \text{health}_{it} + \Delta X_i' \cdot \beta_2 + \Delta \mu_i + \Delta \psi_i + \epsilon_{it}
  \]
  – \text{i}: individual, \text{t}: survey year (2006, 08, 10, 12, 14);
  – \text{drive}: individual i has driven (1/0) in survey year t;
  – \text{health}: health conditions for individual i in survey year t;
  – \text{X}: poverty, employment status, single-family residence, living alone, age, census divisions (proxy for senior citizen licensing policies);
  » Gender and race: interaction models
  – \mu: unobservable factors common to all persons in survey year t;
  – \psi: unobservable factors for individual i

Health conditions

• General health:
  – Sub-par self-rated health (“fair” or “poor”);
• Physical conditions:
  – Underweight/overweight/obese, difficulties in activities of daily living, difficulties in using large muscles, high blood pressure, heart disease, arthritis;
• Cognitive or potentially related conditions:
  – Stroke, depression, memory problems, sleep problems, psychiatric diseases;
• Vision:
  – Problems with distant vision, problems with near vision.
Sample

- Respondents 65+ yrs who have reported changes in their driving status across these five points.

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2008</th>
<th>2010</th>
<th>2012</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have driven in the past month</td>
<td>0.93</td>
<td>0.73</td>
<td>0.53</td>
<td>0.37</td>
<td>0.18</td>
</tr>
<tr>
<td>Age</td>
<td>76.2</td>
<td>77.6</td>
<td>79.0</td>
<td>80.1</td>
<td>81.3</td>
</tr>
<tr>
<td>Below poverty line</td>
<td>0.08</td>
<td>0.10</td>
<td>0.12</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>0.80</td>
<td>0.79</td>
<td>0.78</td>
<td>0.77</td>
<td>0.75</td>
</tr>
<tr>
<td>Non-Hispanic African-American</td>
<td>0.12</td>
<td>0.12</td>
<td>0.13</td>
<td>0.13</td>
<td>0.14</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.07</td>
<td>0.07</td>
<td>0.08</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>Female</td>
<td>0.62</td>
<td>0.62</td>
<td>0.63</td>
<td>0.63</td>
<td>0.66</td>
</tr>
<tr>
<td>N</td>
<td>2,328</td>
<td>2,440</td>
<td>2,328</td>
<td>2,097</td>
<td>1,706</td>
</tr>
</tbody>
</table>

Results

- Sub-par self-rated health negatively impacts senior driving

Coefficients of factors on driving for 65+

<table>
<thead>
<tr>
<th>Sub-par health</th>
<th>Poverty</th>
<th>Employed</th>
<th>Single family</th>
<th>Living alone</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.579</td>
<td>-0.282</td>
<td>0.369</td>
<td>0.353</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other factors:

- No variation by gender, poverty and employment

Coefficients of sub-par health on driving for 65+ (in different profiles)

- Poor physical conditions negatively impact senior driving

Coefficients of physical conditions on driving for 65+

<table>
<thead>
<tr>
<th>Underweight</th>
<th>Overweight</th>
<th>Obese</th>
<th>Arthritis</th>
<th>Heart</th>
<th>Blood pressure</th>
<th>Large muscle activity of daily living</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.517</td>
<td>0.364</td>
<td>0.452</td>
<td>-1.106</td>
<td>-0.533</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Results

• Poor cognitive and vision conditions negatively impact senior driving

Coefficients of cognitive/vision conditions on driving for 65+

<table>
<thead>
<tr>
<th>Condition</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>-0.812</td>
</tr>
<tr>
<td>Depression</td>
<td>-0.546</td>
</tr>
<tr>
<td>Memory</td>
<td>-0.234</td>
</tr>
<tr>
<td>Sleep</td>
<td>-0.194</td>
</tr>
<tr>
<td>Psychiatric</td>
<td>-0.338</td>
</tr>
<tr>
<td>Dist. Vision</td>
<td>-0.456</td>
</tr>
<tr>
<td>Near Vision</td>
<td>-0.278</td>
</tr>
</tbody>
</table>

(Appendix 2)

Discussions

• Challenges ahead:
  – The elderly drive less when their health declines;
  – Currently, transit cannot compensate;

• Policy Directions
  – A more flexible, convenient and senior-friendly transit;
  – Work with health providers to identify mobility needs;
  – Self-driving automobiles?

• Future research: geo-coded HRS sample:
  – Neighborhood and metropolitan level built environment patterns;
  – Impact of health on driving with different levels of senior driving licensure policies.

Odds ratio

• Odds ratio:
  \[ \text{odds ratio} = \frac{P(y = 1|x = 1)}{P(y = 0|x = 1)} \times \frac{P(y = 0|x = 0)}{P(y = 0|x = 0)} = \exp(\beta). \]

  For instance:
  – The odds ratio of sub-par self-rated health (shlt45): -0.579, \( \exp(-0.579) = 0.561 \)

  \[ 0.561 = \frac{P(\text{drive} = 1|\text{shlt45} = 1)}{P(\text{drive} = 1|\text{shlt45} = 0)} \times \frac{P(\text{drive} = 0|\text{shlt45} = 1)}{P(\text{drive} = 0|\text{shlt45} = 0)} \]

Thx!
A general model

• Model with all health variables except general health
  – Physical conditions:
    • BMI (underweight, overweight, obese), difficulties in activities of daily living, difficulties in activities using large muscles, high blood pressure, heart disease, arthritis;
  – Cognitive conditions:
    • Stroke, depression, memory problems, sleep problems, psychiatric diseases;
  – Vision conditions:
    • Problems with distant vision, problems with near vision.
(Note: significant, not significant)

Theory

• Capability theory (Fuller, 2005)

- Health conditions
- Functional limitations
- Self-regulations
- Decision to drive
- Capability
- Task demands