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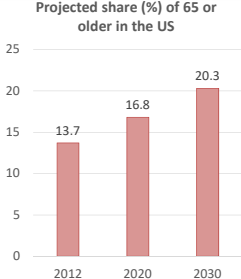
The impact of health conditions on senior driving:
A national-level longitudinal study using the Health and Retirement Study (HRS)

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April 19, 2017

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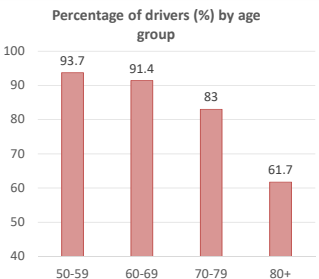
Motivation

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



Year	Projected share (%)
2012	13.7
2020	16.8
2030	20.3

Percentage of drivers (%) by age group



Age Group	Percentage of drivers (%)
50-59	93.7
60-69	91.4
70-79	83
80+	61.7

<http://www.census.gov/prod/2014pubs/p25-1140.pdf> Santos, A., N. McGuckin, H. Nakamoto, D. Gray, and S. Liss. Summary of Travel Trends: 2009 National Household Travel Survey, 2011.

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Motivation

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



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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.

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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.

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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

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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
 - In 2006, 2008, 2010, 2012 & 2014
 - For persons 65 & older:

```

    graph TD
      Q1["Are you able to drive?"] --> Y1["Yes"]
      Q1 --> N1["No/have never driven"]
      Y1 --> Q2["Have you driven a car in the past month?"]
      Q2 --> Y2["Yes"]
      Q2 --> N2["No"]
      style Y1 stroke-dasharray: 5 5
      style Q2 stroke-dasharray: 5 5
      style Y2 stroke-dasharray: 5 5
      style N2 stroke-dasharray: 5 5
      style N1 stroke-dasharray: 5 5
    
```

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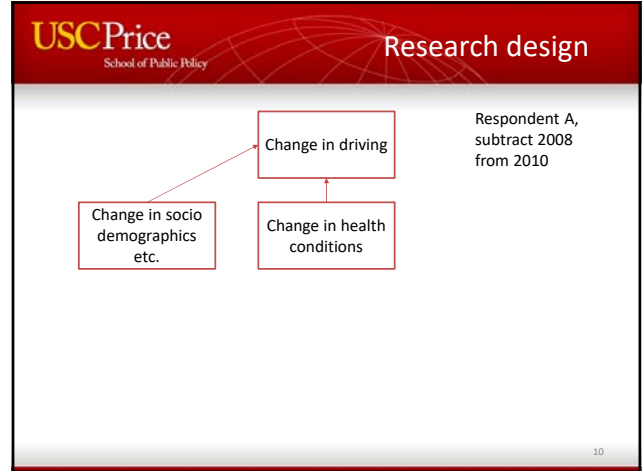
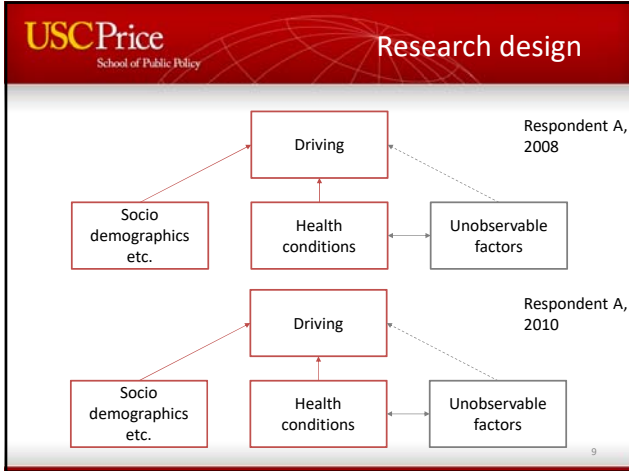
Research design

- Why panel data?

```

    graph TD
      SD["Socio demographics etc."] --> D["Driving"]
      HC["Health conditions"] --> D
      HC <--> UF["Unobservable factors"]
      UF --> D
      RA["Respondent A, 2010"] -.-> D
      style D stroke-dasharray: 5 5
      style RA stroke-dasharray: 5 5
    
```

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- Fixed-effects logit model:

$$drive_{it} = \beta_0 + \beta_1 health_{it} + \mathbf{X}'_{it} \cdot \beta_2 + \mu_t + \nu_i + \varepsilon_{it}$$

$$\Delta drive_{it} = \beta_1 \Delta health_{it} + \Delta \mathbf{X}'_{it} \cdot \beta_2 + \Delta \mu_t + \Delta \varepsilon_{it}$$
 - i : individual, t : survey year (2006, 08, 10, 12, 14);
 - $drive_{it}$: individual i has driven (1/0) in survey year t ;
 - $health_{it}$: health conditions for individual i in survey year t ;
 - \mathbf{X}_{it} : poverty, employment status, single-family residence, living alone, age, census divisions (proxy for senior citizen licensing policies);
 - » Gender and race: interaction models
 - μ_t : unobservable factors common to all persons in survey year t ;
 - ν_i : unobservable factors for individual i

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USCPrice School of Public Policy 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.

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

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

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

Coefficients of factors on driving for 65+

Factor	Coefficient	Significance
sub-par health	-0.579	significant
poverty	-0.282	not significant
employed	1.136	significant
single-family houses	0.369	not significant
living alone	0.353	not significant
age	-0.517	not significant

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- Sub-par health impact on driving varies by living status (alone/not), residence (single family housing) and race
- No variation by gender, poverty and employment

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

Profile	Coefficient	Significance
living alone - yes	-0.386	not significant
living alone - no	-0.686	significant
single family housing - yes	-0.681	significant
single family housing - no	-0.343	not significant
other races	-0.684	significant
black	-0.183	not significant

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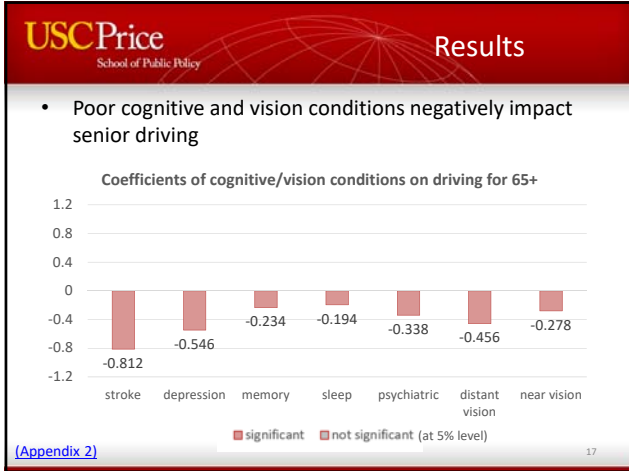
USCPrice School of Public Policy Results

- Poor physical conditions negatively impact senior driving

Coefficients of physical conditions on driving for 65+

Condition	Coefficient	Significance
underweight	-0.517	not significant
overweight	0.364	not significant
obese	0.452	not significant
activities of daily living	-1.106	significant
large muscle	-0.533	not significant
blood pressure	0.1	not significant
heart	-0.1	not significant
arthritis	0.2	not significant

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- ## 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.
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Odds ratio

- Odds ratio:

$$\widehat{odds\ ratio} = \frac{\hat{P}(y = 1|x = 1) / \hat{P}(y = 0|x = 1)}{\hat{P}(y = 1|x = 0) / \hat{P}(y = 0|x = 0)} = \exp(\beta)$$
- For instance:
 - The odds ratio of sub-par self-rated health (*shlt45*): -0.579, $\exp(-0.579) = 0.561$

$$0.561 = \frac{\hat{P}(drive = 1|shlt45 = 1) / \hat{P}(drive = 0|shlt45 = 1)}{\hat{P}(drive = 1|shlt45 = 0) / \hat{P}(drive = 0|shlt45 = 0)}$$

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USC Price School of Public Policy **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)

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USC Price School of Public Policy **Theory**

- Capability theory (Fuller, 2005)

The diagram illustrates the Capability Theory (Fuller, 2005) model. It consists of two rows of boxes. The top row has 'Health conditions' on the left, and 'Functional limitations' and 'Self-regulations' on the right. The bottom row has 'Decision to drive' on the left, and 'Capability' and 'Task demands' on the right. A solid arrow points from 'Health conditions' to 'Functional limitations'. A solid arrow points from 'Functional limitations' to 'Self-regulations'. A solid arrow points from 'Self-regulations' to 'Decision to drive'. A solid arrow points from 'Decision to drive' to 'Capability'. A solid arrow points from 'Capability' to 'Task demands'. A dashed box encloses 'Functional limitations' and 'Self-regulations'. Another dashed box encloses 'Capability' and 'Task demands'. A downward arrow points from the top dashed box to the bottom dashed box.

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