Vehicle Retirement and California’s Carbon Emissions

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• 26 million light duty vehicles (cars, SUVs, etc) registered in California

• The great majority are used cars, and burn gasoline

• 22% of 20 year old cars remain on the road (and 28% of SUVs and pickups)

• Zero-carbon vehicle sales are accelerating: 1.6% in 2014, 4.5% in 2018 (and nearly double this if counting PHEVs)

What determines if this (gasoline) vehicle will be scrapped, or repaired and driven another 100,000 miles?
Changes in the Used Fleet

- Because cars last so long, changes in the used fleet are important for policy.

- Understudied in economics: many policy analyses assume a fixed profile of scrappage.

- Literature: “Cash-for-clunkers” evaluations (e.g. Mian & Sufi, 2012), “Scrap bounty” evaluations (e.g. Hahn (1995), Alberini, Harrington & McConnell (1998)).

- Less work looking at sustained scrappage behavior, or the long term ability of policy to alter scrappage.
Presentation Today

- Results from Jacobsen and van Benthem (2015)
  - The *scrap elasticity*
- Preliminary findings from Jacobsen, Sallee, Shapiro, and van Benthem (2019 working paper)
  - Changing local air pollution by using scrappage policy
- Discussion: the role of scrappage in reducing or eliminating California’s transportation carbon
“Vehicle Scrappage and Gasoline Policy”

Uses gasoline price changes to study the elasticity of the scrap rate with respect to used vehicle prices:

\[
\text{scrap elasticity} \equiv \frac{\% \text{ change in scrappage}}{\% \text{ change in price}}
\]
Effect of a $1 Gasoline Price Increase on Used Vehicle Prices

The graph shows the relationship between miles per gallon and log price for different types of vehicles. The x-axis represents miles per gallon, ranging from 15 to 30, and the y-axis represents the log price, ranging from -2 to 2. Different colors and symbols are used to distinguish between light trucks (red circles) and sedans (blue circles).
### Link to Scrappage ($1 change in fuel price)

<table>
<thead>
<tr>
<th>Fuel Economy</th>
<th>Used vehicle value</th>
<th>Annual scrap rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 MPG</td>
<td>-$786</td>
<td>+1.6</td>
</tr>
<tr>
<td>20 MPG (average vehicle)</td>
<td>-$227</td>
<td>+0.3</td>
</tr>
<tr>
<td>35 MPG</td>
<td>+$611</td>
<td>-1.5</td>
</tr>
</tbody>
</table>

(Typical vehicle valued at $7,000 with scrap rate of 3% per year)

Elasticity is approximately -0.7, with some important differences by age and type of vehicle.
“Optimal Corrective Taxes with Untaxable Externalities: Evidence from Vehicle Pollution Standards”

- Large scale health damages occur due to pollution from cars, almost impossible to attribute to individual cars

- Key existing regulations are “tailpipe” standards, mandating specific control equipment

- We document the remarkable effectiveness of tailpipe standards, and then show how **dramatic additional gains are possible using scrappage policy**
Emissions Across Vintages: Nitrogen Oxides

- NOx first regulated in 1972
- Log scale
Pollution and Vehicle Age

Plot coefficients control for vehicle FEVs, and odometer reading.
Pollution and Odometer

Plotted coefficients control for vehicle FEs, and vehicle age
Influencing Retirement

- **Pulling** cars into retirement: scrap subsidy
  - Pros: opt-in, average financial transfer is toward low-income groups
  - Cons: unnecessary payment to people who would scrap anyway, reduces the average cost of driving (relative to public transport)

- **Pushing** cars into retirement: registration fee system
  - Pros: increases the average cost of driving (relative to public transport), raises revenue
  - Cons: unpopular, falls more heavily on low-income groups
Sample results (not final)

- Health damages caused by a typical vehicle:
  - Age 0-5  $36/year
  - Age 15-20 $607/year

- Typical values of 15-20 year old vehicles (~$1000) mean small changes in fees have a large influence on scrappage

- Repair decisions take account of cumulated future fees, not just one year

- Scrap effects in the middle of the age distribution (around 10 years) also turn out to be quite important
Discussion

• Scrappage helps with air pollution, and will also be a critical part of moving to a zero-carbon transport fleet

• Relatively easy to change scrappage using fees and subsidies
  • Pros/cons of pushes and pulls?
  • California’s current registration fee structure

• Scrappage policy is more important the faster is the desired transition, and is part of most economically efficient strategies to transform the fleet