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

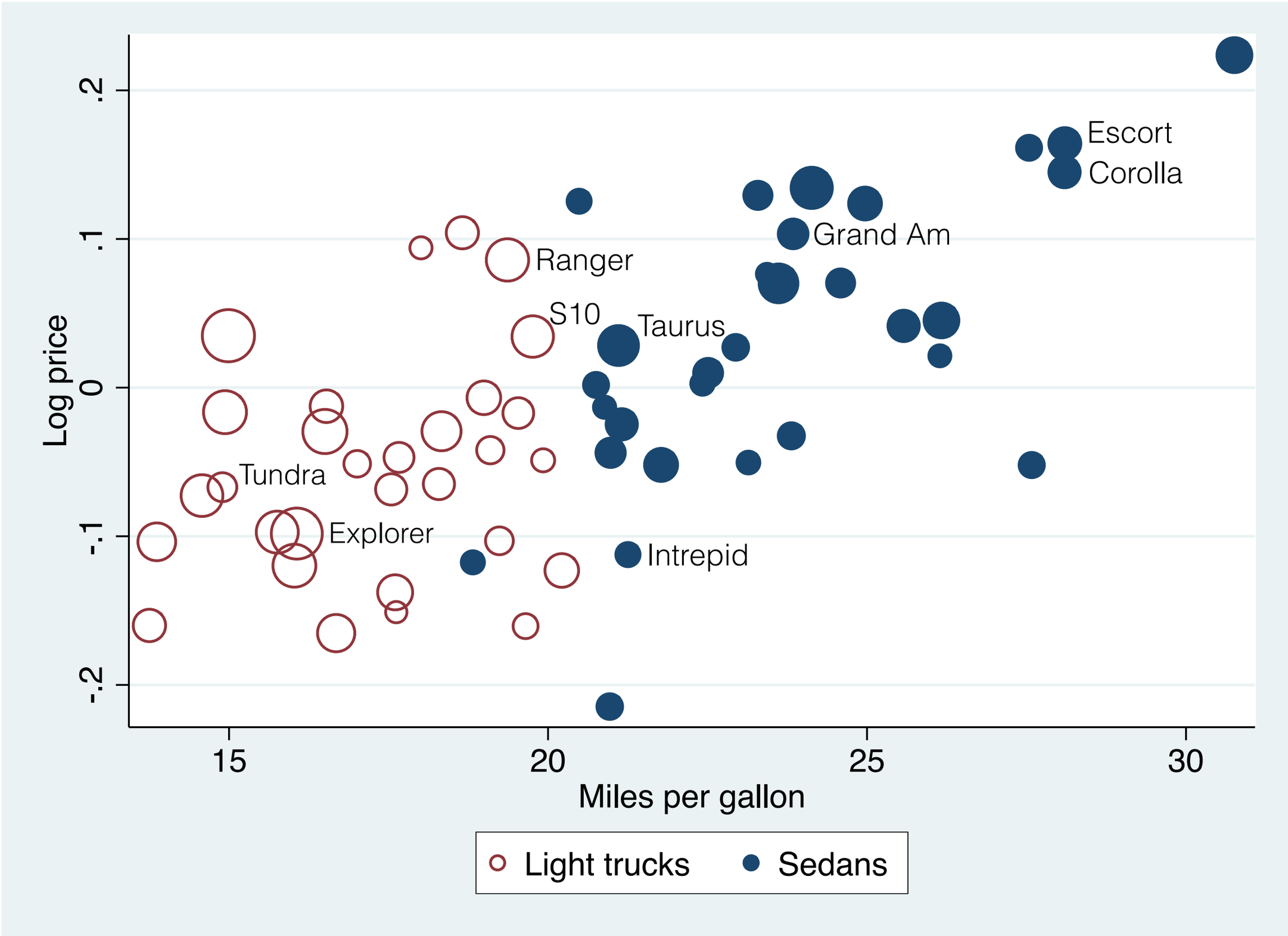
- Results from Jacobsen and van Benthem (2015)
  - The *scrap elasticity*
- Preliminary findings from Jacobsen, Sallee, Shapiro, and van Benthem (2019 working paper)
  - Changing local air pollution by using scrappage policy
- Discussion: the role of scrappage in reducing or eliminating California's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



Link to Scrappage ($1 change in fuel price)

Fuel Economy	Used vehicle value	Annual scrap rate
15 MPG	-$786	+1.6
20 MPG (average vehicle)	-$227	+0.3
35 MPG	+$611	-1.5

(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

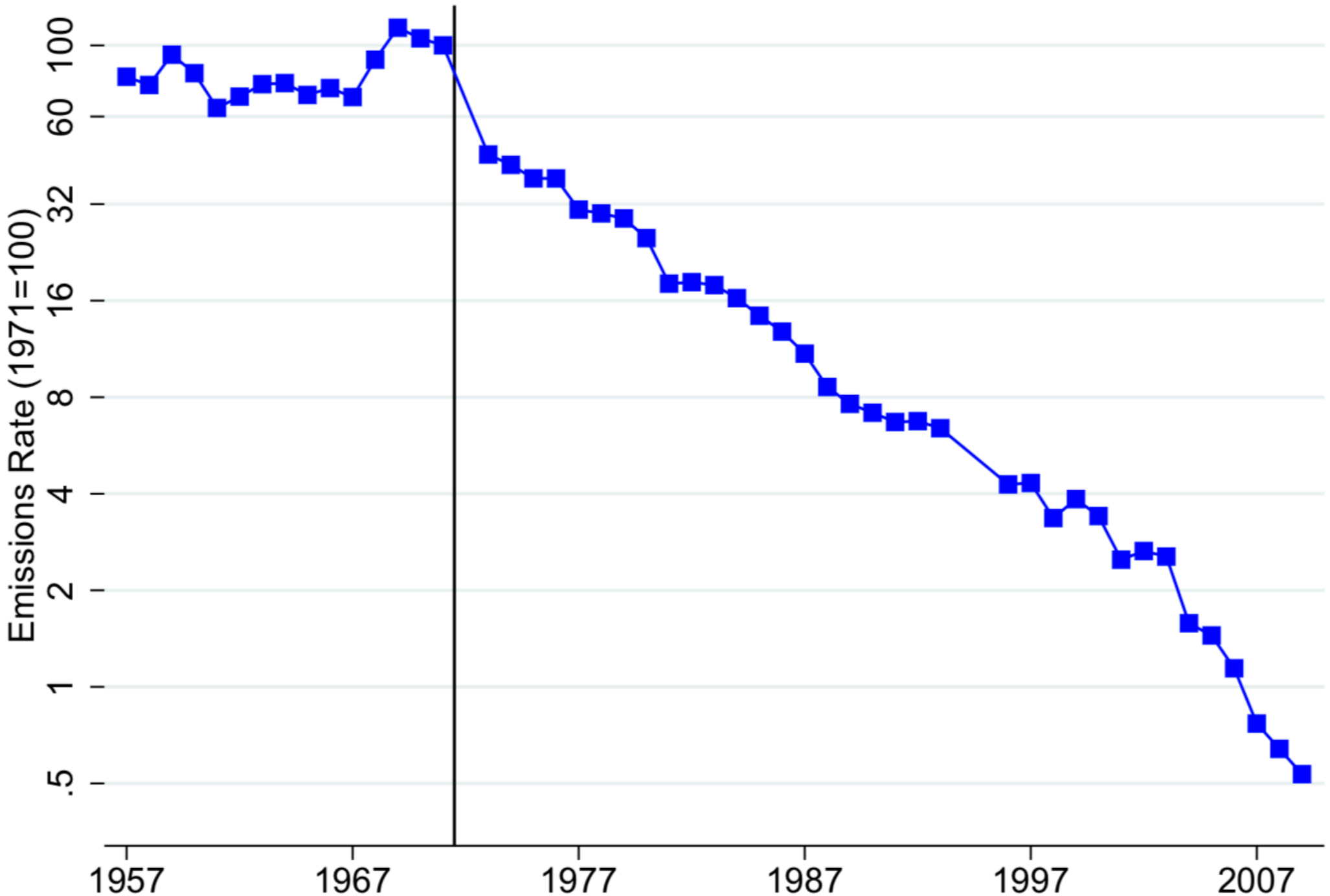
“Optimal Corrective Taxes with Untaxable Externalities: Evidence from Vehicle Pollution Standards”

- 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

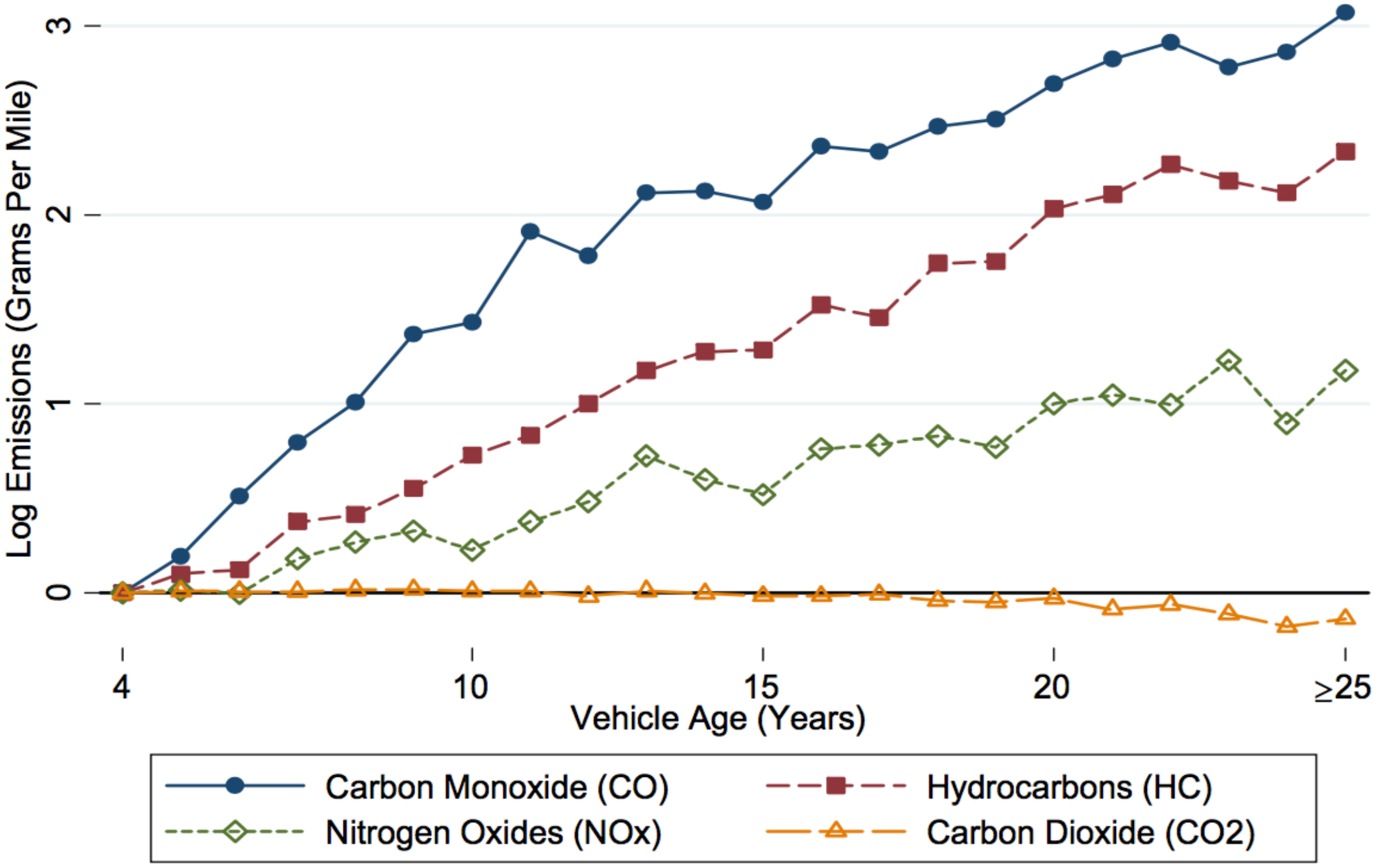
- We document the remarkable effectiveness of tailpipe standards, and then show how **dramatic additional gains are possible using scrappage policy**

Emissions Across Vintages: Nitrogen Oxides



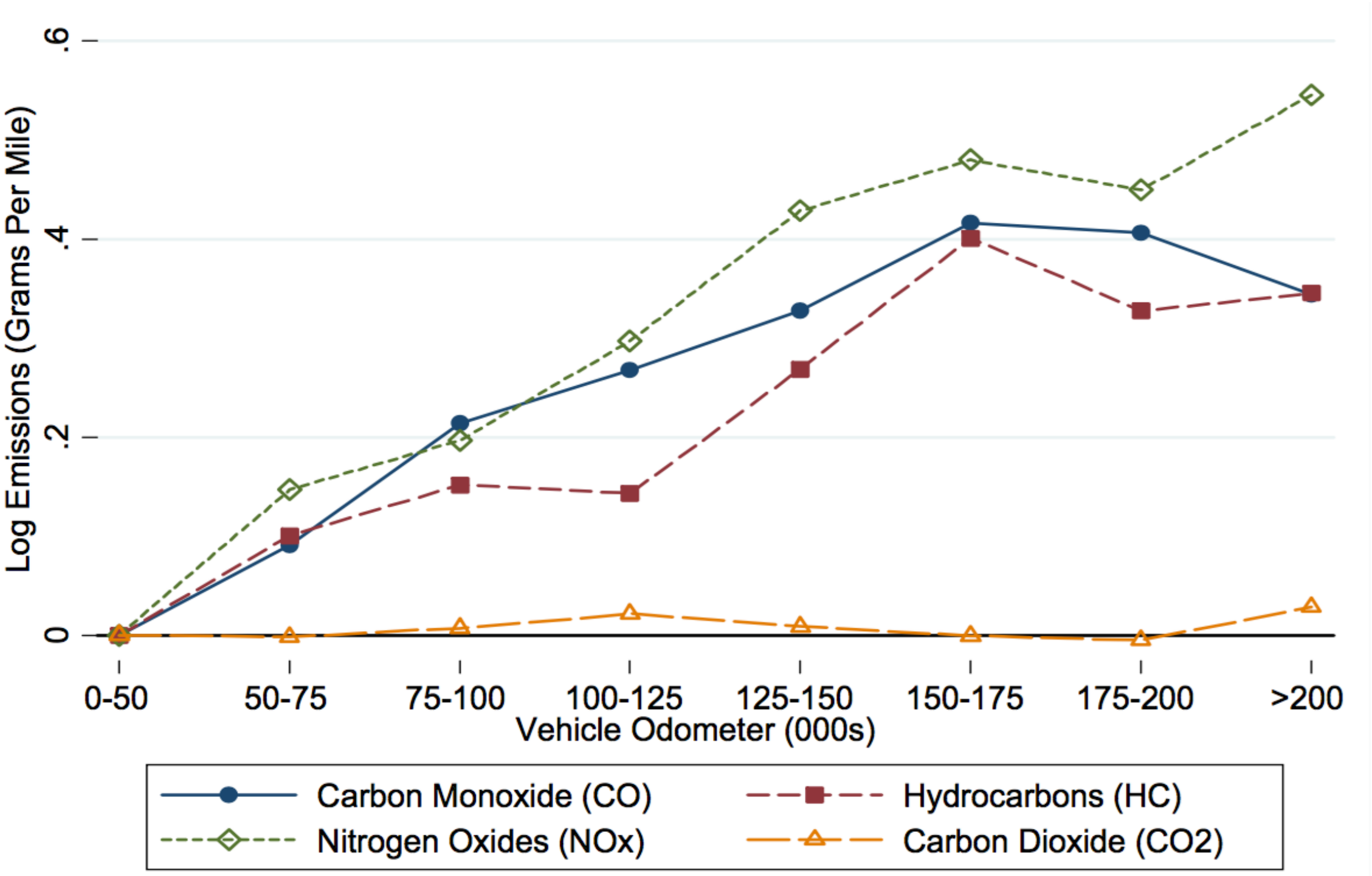
- NOx first regulated in 1972
- Log scale

Pollution and Vehicle Age



Plotted coefficients control for vehicle FEs, 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