Carnegie Mellon University

Externalities of Policy-Induced Scrappage:

The Case of Automotive Regulations

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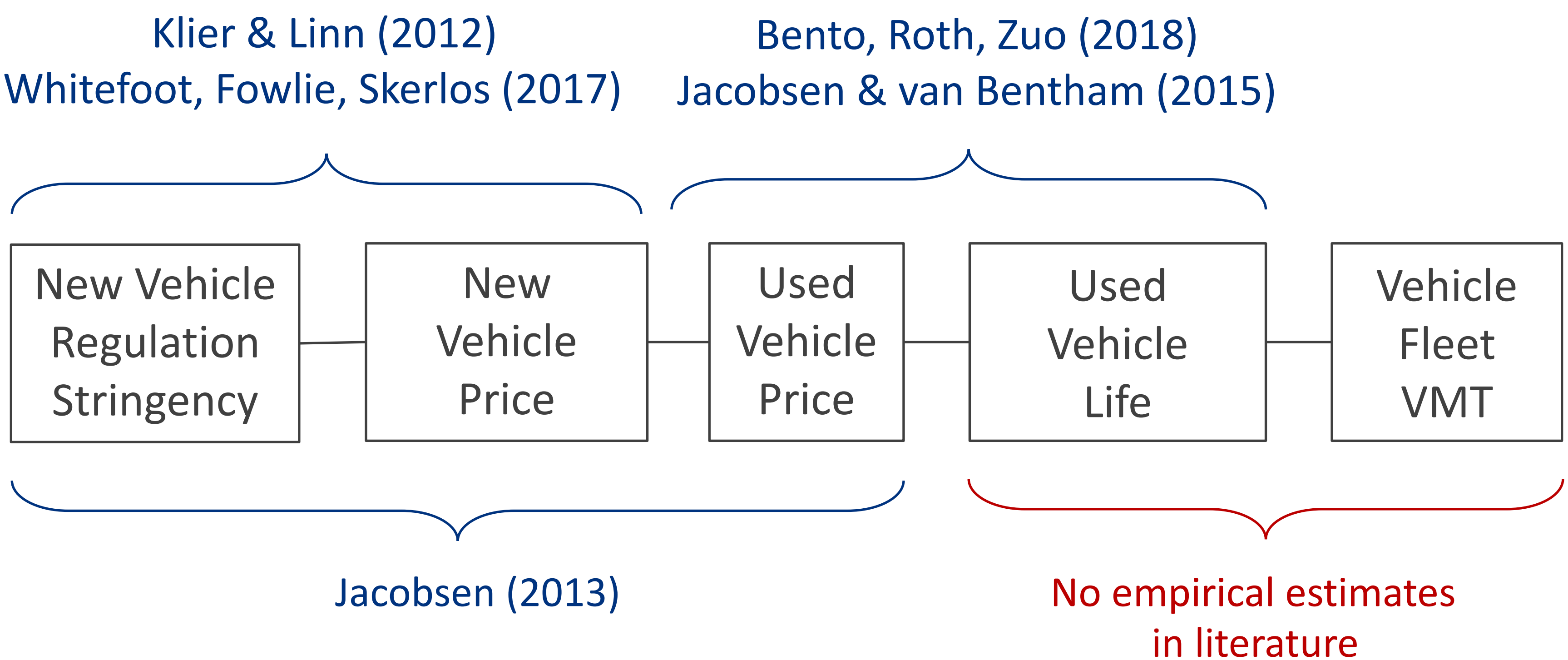
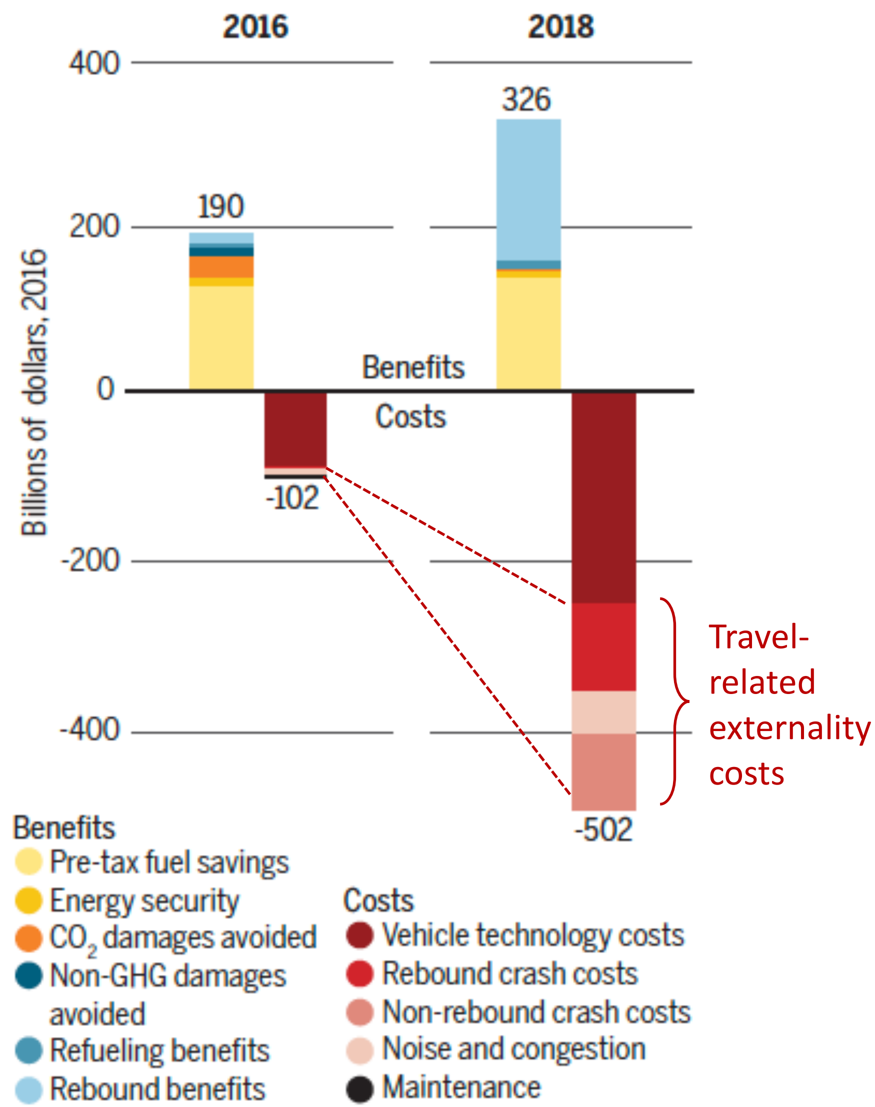
Policies Affect Fleet Scrappage & Travel

- *Gruenspecht Effect*: policies that delay scrappage of used vehicles can cause significant externalities due to additional vehicle travel



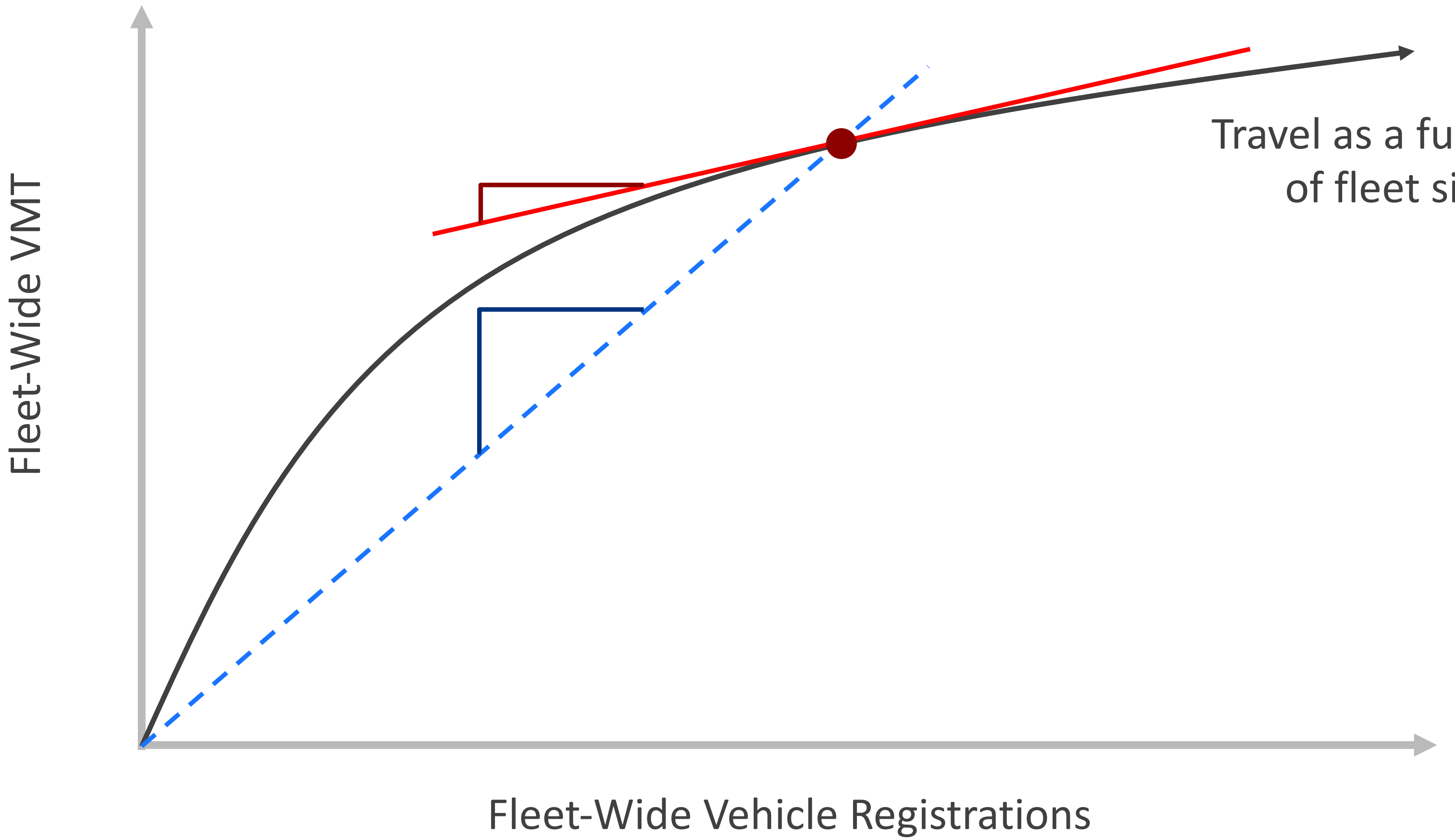
Potentially Large Effects on Policy Costs & Benefits

- Delayed scrappage and additional travel significantly affect policy costs & benefits
- Applies to many policies:
  - Fuel economy standards
    (Bento, Roth, Zuo 2018, Jacobsen & van Bentham 2015, Jacobsen 2013)
  - Fuel taxes
    (Jacobsen & van Bentham 2015)
  - Safety & emissions inspections
    (Hahn 1995)
  - Vehicle subsidies
  - Import/Export restrictions
    (Mannering and Winston 1987)



(Bento et al. 2019)

Marginal Miles Travelled ≠ Average



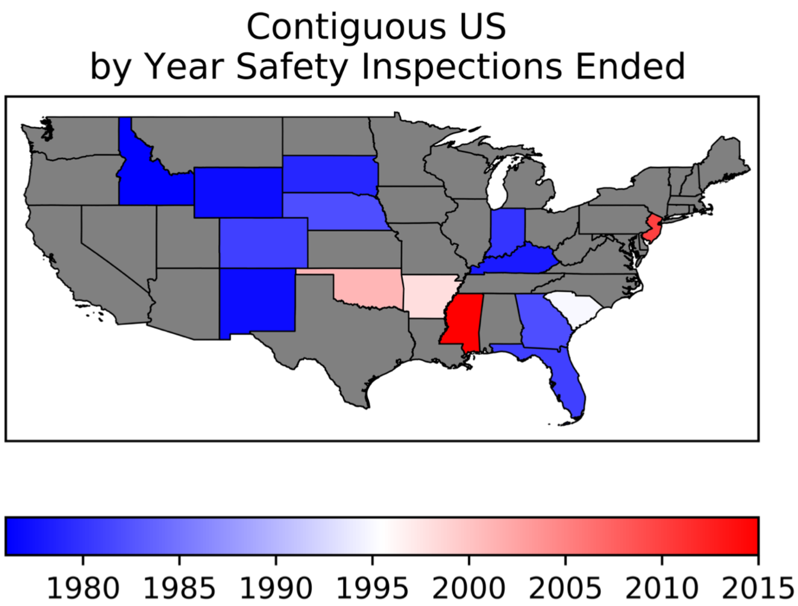
Exogenous shock to scrappage

- Want: shock to scrappage
- Affects fleet travel only through the change in fleet size

$$\text{Vehicle Value}_{it} - \text{Repair Costs}_{it} < \text{Scrap Value}_{it} \qquad \text{for vehicle } i, \text{time } t$$

- Exploit data on removal of vehicle safety inspections as exogenous shock
  - Reduces repair costs
  - Expected to delay scrappage
  - Does not otherwise affect travel demand

Staggered Safety Inspection Removal



- 31 states & DC implemented safety inspection programs
- 15 states & DC removed these programs before 2017
- Vehicles required to pass safety inspection (with all required repairs) every 1-2 years
- Expiration of inspection sticker leads to fines, suspension of registration

State map image source: census.gov

Registration & Travel Data

Vehicle Registration & Travel Data

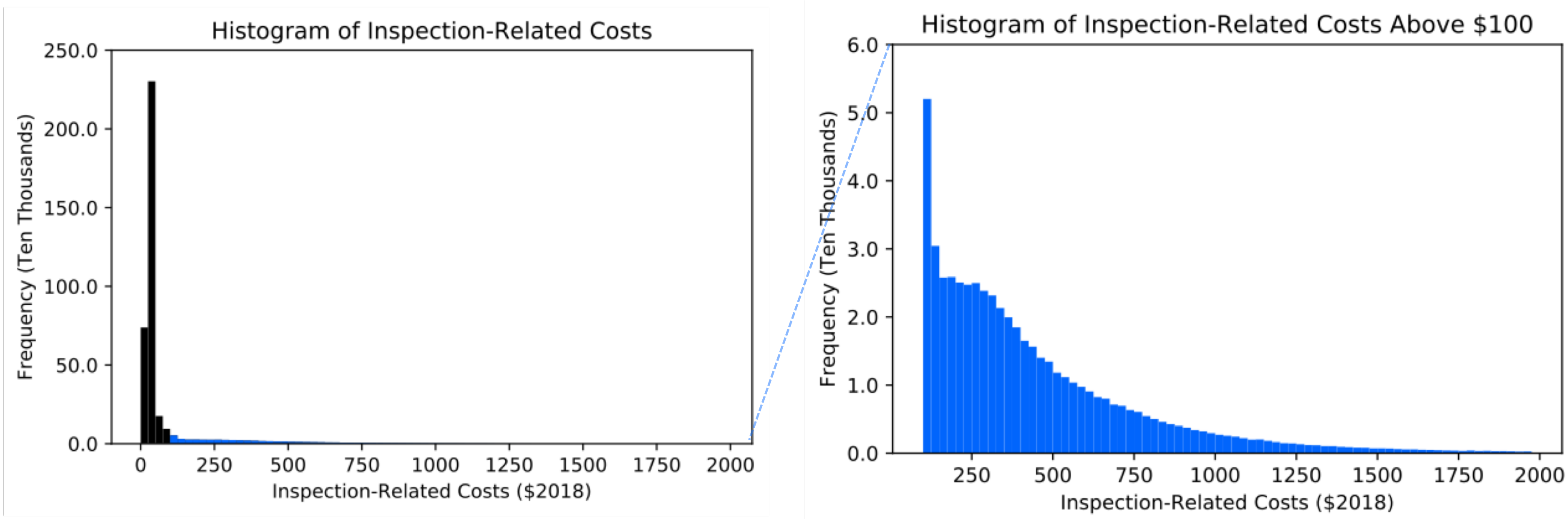
- Federal Highway Administration (FHWA) Highway Statistics
  - Vehicle registration data at state and year level, 1967-2017
  - Vehicle miles traveled at state and year level, 1967-2017
  - Licensed Drivers, Road Mileage, 1967-2017

State Economic & Highway Data

- Energy Information Administration
  - Average Motor Gasoline Price, 1970-2017
- Bureau of Economic Analysis
  - Population (Metro, Non-metro), Income, 1969-2017
  - GDP, 1967-2017

Inspection Related Costs

- Data from Pennsylvania inspection program



- Some vehicles have large repair costs: $1,000 +
- Average vehicle price (Jacobsen & van Bentham, 2015):
  - < $5,000 after age 10
  - ~ $2,000 age 15-19

Two-Stage IV Regression

Vehicle registrations
for state “i” in year “t”

First stage:

$$\log(r_{iy}) = \psi_i + \gamma_y + \xi_i\, y + \eta\, d_{iy} + \boldsymbol{\alpha}'\mathbf{x}_{iy} + \varepsilon_{iy}$$

Treatment dummy:
removal of inspections

Travel (VMT)

Second stage:

$$\log(v_{iy}) = \phi_i + \zeta_y + \omega_i y + \beta\, \widehat{\log(r_{iy})} + \boldsymbol{\delta}'\mathbf{x}_{iy} + \epsilon_{iy}$$

Fleet-size elasticity of travel

Compare Elasticity to Common Assumptions

Null Hypothesis

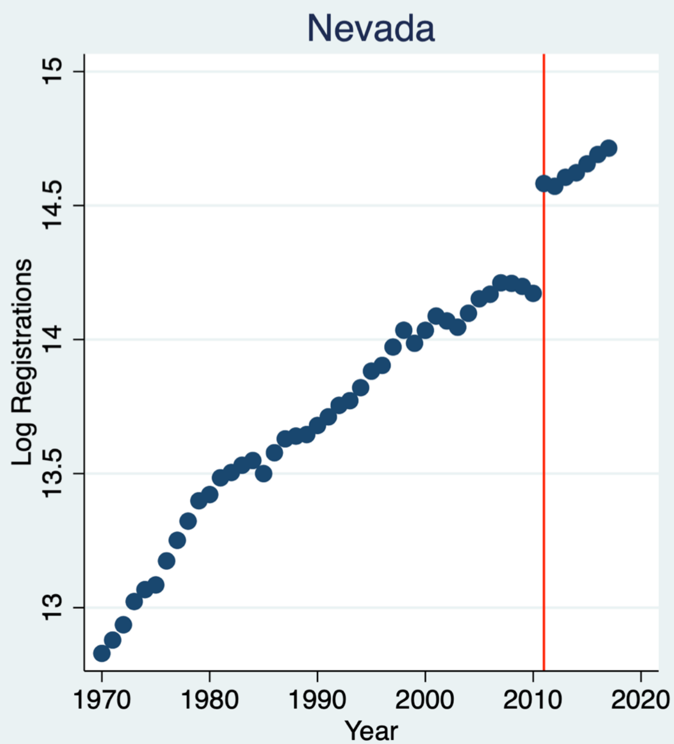
- H_0 is <u>not</u> $\beta=0$, but marginal = average VMT within group
  - Corresponds to $\beta=1$ within vehicle group (Gruenspecht 1982; Jacobsen and van Bentham 2015; NHTSA 2018)
  - We calculate implied aggregated fleet-wide elasticities
  - Depends on fleet composition of vehicles

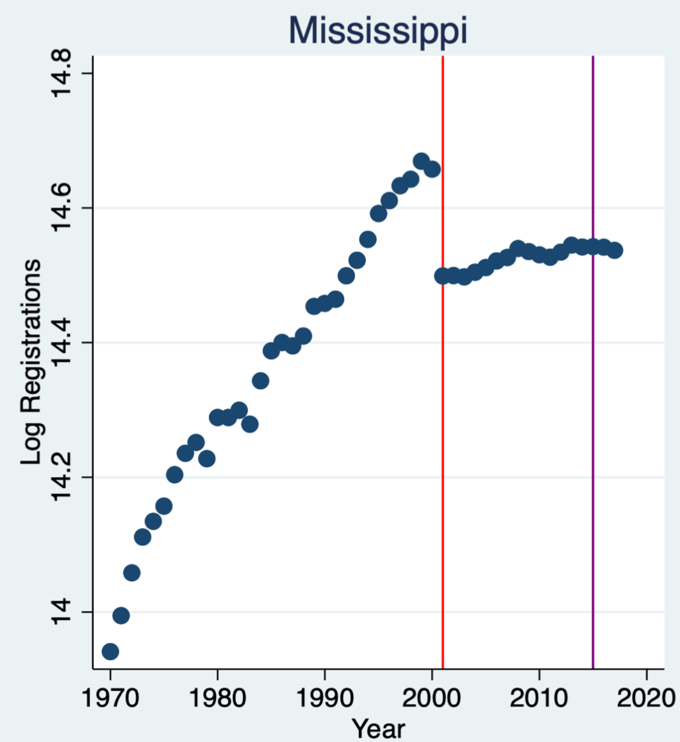
NHTSA (2018) analysis

- For Model-Years 2018-2025, $\beta \approx 1$

➢ Test $\mathrm{H}_0: \beta = 1$

Control for data discontinuities





Note: Different Y-Axes
Purple lines denote removal of safety inspection
Red lines denote major discontinuities

Threats to Identification

- **Endogeneity of Treatment?**
  - ➢ Repeals focused on lack of evidence that inspections improved traffic safety, and budgetary constraints (NHTSA 1989, GAO 2015)

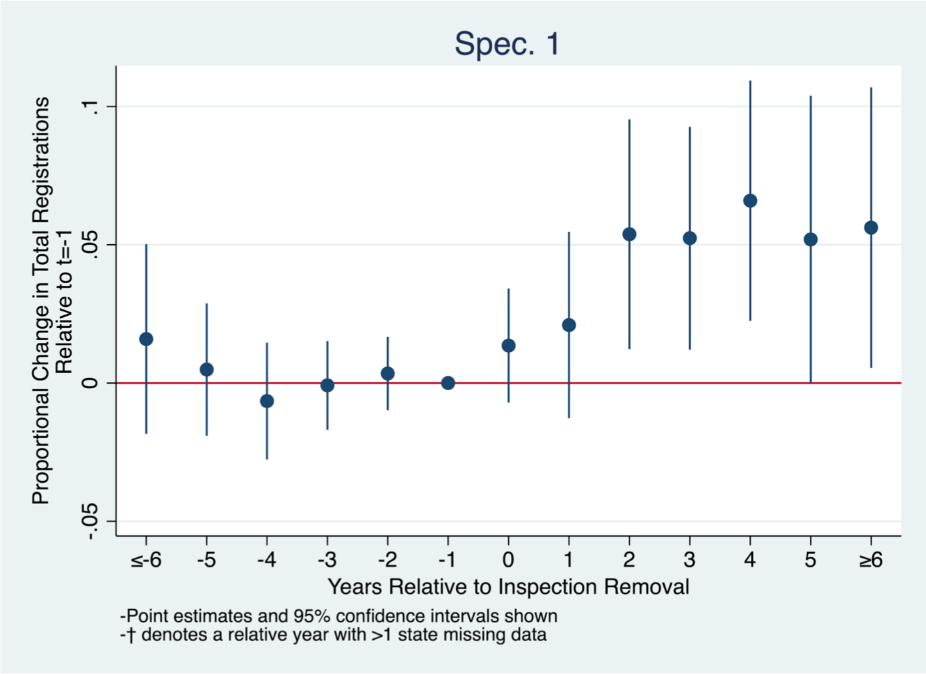
- **Endogeneity of Instrument?**
  - ➢ Negligible changes to household budget: $1-$1.50 more fuel

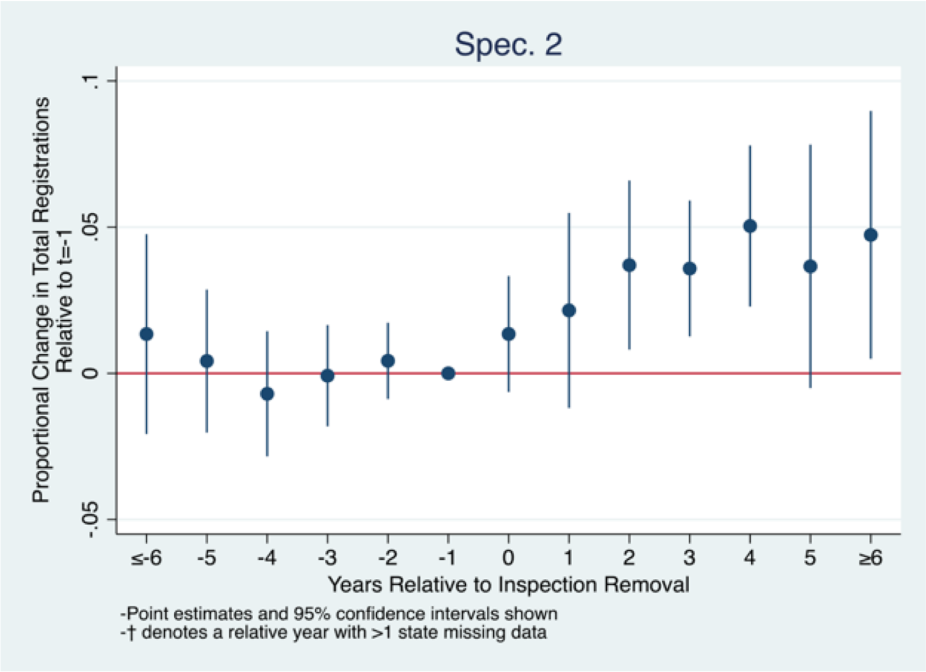
- **Parallel trends?**
  - Expect state registrations affected by population, income, propensity for vehicle travel over other modes
  - ➢ Control for population, economic variables (GDP, income, employment), Metro and Non-metro population, and gas prices
  - Pre-trend testing with an event study

Event Study of Safety Inspection Removal

Indicator for "t" years relative to safety inspection removal

$$\log(r_{iy}) = \psi_i + \gamma_y + \xi_i\, y + \sum_{t=-6}^{6} \eta_t\, s_{iyt} + \boldsymbol{\alpha}'\mathbf{x}_{iy} + \varepsilon_{iy}$$





Safety Inspection Impact on Registrations

	(1) Spec. 1 b/se	(2) Spec. 2 b/se
No Safety Inspections	0.039**	0.030*
	(0.016)	(0.016)
Observations	2438	2438
Kleibergen-Paap rk Wald F-Stat	5.970	3.377

* p <0.1, ** p <0.05, *** p <0.01

Note: Robust standard errors clustered by state. All models include state and year fixed effects as well as state linear-time trends.

Fleet-Size Impact on Travel

	(1) Spec. 1	(2) Spec. 2
Log Registrations (β)	-0.49	-0.55
AR Confidence Set (95%)	[-8.76, .62]	$[-\infty, \infty]$
AR Confidence Set (90%)	[-3.27, .38]	[-308.38 , .85]
$\mathbf{H_0}$: $\beta = 1$		
AR-χ^2	5.17**	2.93*
P-Value	0.02	0.09

* p <0.1, ** p <0.05, *** p <0.01

Note: Robust standard errors clustered by state. All models include state and year fixed effects as well as state linear-time trends.

Implications and Uncertainty

- Consequences of not rejecting $\mathrm{H}_0 : \beta = 1$ if not true
  - Overestimate travel-related externalities of fuel economy standards by 12% or more (Jacobsen & van Bentham 2015)
  - \$100's of billions of fatality, congestion, & emissions welfare impacts
  - Significant influence on cost-benefit & appropriate level of regulations

Conclusion

- Empirically measure the marginal change in VMT from increased fleet size due to delayed scrappage
- Estimate removal of safety inspections causes 3-4% increase in vehicle registrations, but with uncertainty
- Small sample of state-level treatment prevents us from estimating elasticity of travel with precision
- Reject that fleet-size elasticity of travel, $\beta = 1$ at 90% confidence level

➢ Reveals need for additional measurement of β