Research Overview:
Technology, Vehicle Characteristics,
and Costs of Fuel Economy/GHG Standards

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Recent Research

• Passenger vehicle rebound effect
  ▪ How does fuel economy (as opposed to fuel prices) affect miles traveled?
  ▪ Using NHTS data, address endogeneity of fuel economy and multi-vehicle households

• Effects of tightening standards on vehicle characteristics (with Thomas Klier, Chicago Fed)
  ▪ Examine recent policy developments in US and Europe
  ▪ Focus on properly defining the baseline, against which costs and benefits of tighter standards should be measured
  ▪ How have standards affected:
    ➢ The rate of technology adoption?
    ➢ Vehicle characteristics other than fuel economy?
Why We Need to Model Dynamics?

• Typical approach (in literature, among regulatory agencies) to estimating costs and benefits of tighter standards:
  - Begin with an equilibrium prior to tighter standards (e.g., 2011, for the 2016 standards)
  - Use a computational model to estimate change in fuel economy, vehicle prices, etc., relative to initial equilibrium, such that manufacturers comply

• Figure 1 shows steady increases in horsepower and weight from 1985-2005, when standards were essentially constant
  - The figure suggests manufacturers used power train improvements to increase these characteristics, and would continue to do so in absence of tighter standards

• Therefore, the appropriate baseline, from which to measure costs and benefits, is not the equilibrium prior to the tighter standards
Figure 1: Fraction Change in Fuel Economy, Weight and Power, 1975-2008 for Cars Sold by U.S. Manufacturers

Source: Klier and Linn (2012)
Simple Model to Illustrate the Importance of Dynamics

- Manufacturer starts with a particular power train for a given vehicle, and can add technology to improve efficiency.

- Efficiency fixes location of frontier, which represents combinations of fuel economy and horsepower such that marginal costs are constant.

- Given the efficiency, manufacturer then chooses fuel economy and horsepower, locating along the frontier (see Figure 2).

- Frontier shifts out over time because of innovation and other factors (Figure 3).
Figure 2. Technology Frontier
Figure 3. Equilibrium Without Tighter Standards
Figure 4. Equilibrium with a Tighter Fuel Economy Standard
Implications for Welfare Analysis

• Standards cause more efficiency adoption and movement along the frontier (Figure 4)

• Consumer welfare improves in absence of tighter standards, and should be baseline against which the effects of standards are measured

• Summary
  - Previous welfare analysis rule out certain manufacturer behavior/responses, such as innovation and shifting along the frontier
  - This causes welfare cost estimates to be too high
  - Ignoring technology adoption in absence of tighter standards causes welfare cost estimates to be too low
  - Which effect is bigger?
Evidence from Recently Tightened Standards

- We look at manufacturer behavior in response to four examples of recently tightened standards
  - European cars (2007-2009)

- Evidence that the standards increased the rate of technology adoption

- Evidence the standards reduced US light truck torque (from no-policy case); weaker evidence/smaller effects for US cars and European cars

- Comparing observed equilibrium and estimated counterfactual, consumer valuation of lost torque is same order of magnitude as value of fuel savings
Figure 5: Fuel Economy Technology Adoption for U.S. Light Trucks
Upcoming Research

• Ex post welfare analysis of US light truck standards
  ▪ Preceding welfare estimates were back-of-envelope calculations, lacking fully dynamic model
  ▪ Next: estimate fixed costs of vehicle/engine redesign
  ▪ Challenges to putting together all the pieces: demand estimation, including manufacturer behavioral margins, and cost estimation

• R&D expenditure, patenting, and product improvements
  ▪ Standards, fuel prices, and other factors should affect innovation
  ▪ Very little research on vehicle innovation, particularly focusing on changes in product attributes as opposed to patents
  ▪ How do firms make investment decisions? Strategic interactions?
  ▪ How do consumer preferences and policies affect these decisions?
Other Questions for Discussion

- Empirical analysis of technology incentives for fuel prices, standards, fee-bates

- Consumer demand for other vehicle characteristics

- Uncertainty (regulatory stringency, consumer demand, etc.)

- Effects of crediting rules on costs and benefits of standards