Rebound Effect: Overview and Recent Research

Joshua Linn

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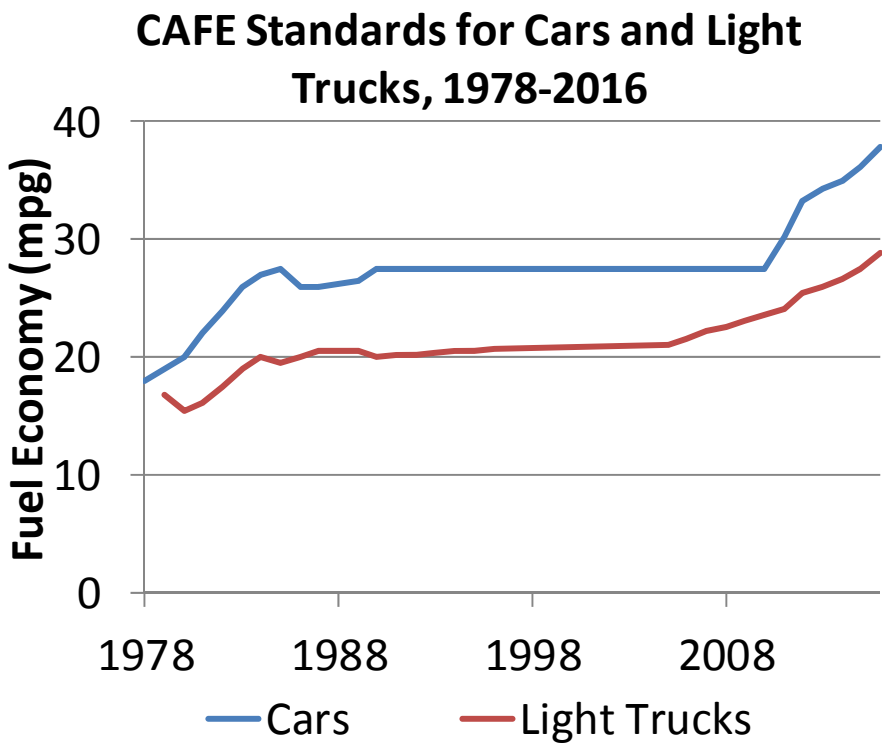
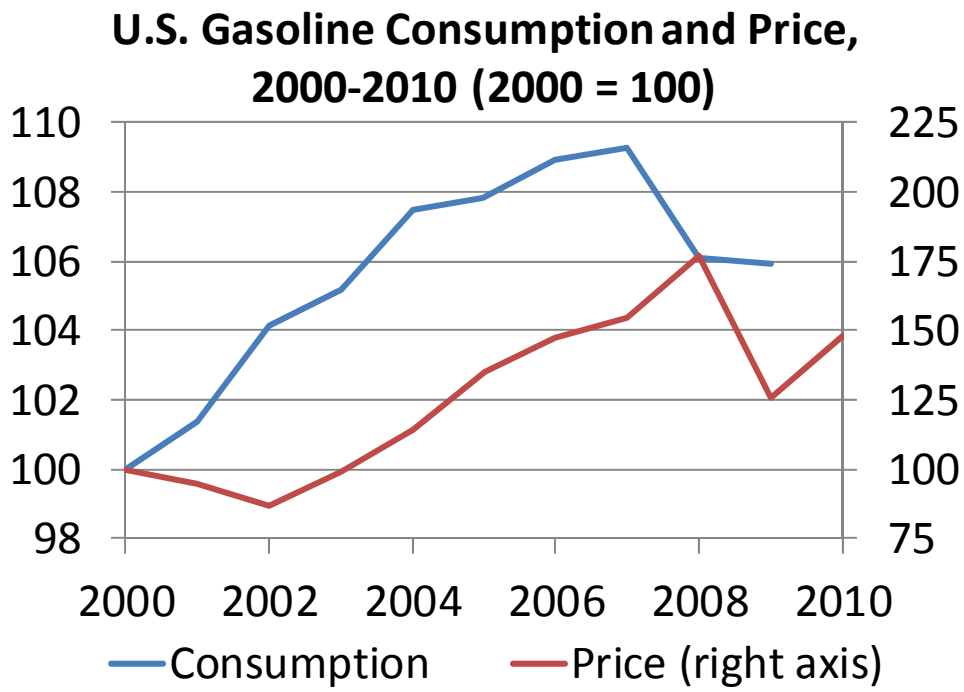
What Is the Rebound Effect?

- Passenger vehicle fuel economy regulation
  - Corporate average fuel economy (CAFE) standards mandate fuel economy of new vehicles sold
  - From 2012 to 2016, 40 percent increase in fuel economy with probably more to come
  - Over time, fuel economy increase for new vehicles translates to entire fleet of vehicles on the road

- Fuel economy and driving
  - Main objective of CAFE is to decrease oil consumption, improving energy security and reducing GHG emissions
  - Higher fuel economy reduces cost of driving, and people drive more than if there were no policy

CAFE Standards and Recent Gasoline Trends





Sources: EPA and EIA

Suggestive evidence VMT responds to gasoline prices … what does this imply for gasoline consumption and CAFE?

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Why is the Rebound Effect Important?

- Environmental, energy security, and other implications
  - More driving means more gasoline consumption, reducing energy security and GHG benefits
  - More driving also means more tailpipe emissions of other pollutants (for example, particulates), and more congestion

- Stepping back for a moment
  - Cap-and-trade: rebound doesn't matter (the cap is the cap)
  - Interested in rebound effect for emissions tax, but …
  - Primary interest is for energy efficiency or similar policies

- Energy efficiency standards are everywhere
  - It's not just CAFE; medium and heavy duty trucks
  - Fossil fuel-fired electricity generators and other sectors

How Do We Estimate the Rebound Effect? (1/3)

- Simple approach
  - Fuel costs depend on fuel price divided by fuel economy:

    $$FC = P_g / MPG$$

  - Assume consumers respond equally to a proportional fuel price decrease as to a proportional fuel economy increase
  - Estimate correlation between fuel prices and miles traveled (or fuel consumption)

- Issues with the simple approach
  - Equivalence of fuel prices and fuel economy may be a strong assumption
  - Hard to be certain this approach controls for fuel economy
  - Difficult to estimate long run rebound effect

Estimating the Rebound Effect (2/3)

- More structural approach
  - Using formal utility maximization model or accounting identities (consumption = VMT/MPG), distinguish household's purchase decision from driving decision

$$VMT = f(MPG, P_g, X)$$

$$MPG = g(P_g, X)$$

  - Account for the fact that determinants of MPG also affect driving
  - Example: a household with a lot of kids will purchase a large vehicle and drive many miles

Estimating the Rebound Effect (3/3)

- Issues with this approach
  - Difficult to separately analyze these decisions
  - Often have to simplify choice set (for example, aggregate to vehicle classes)
  - Typically, make same assumption that gasoline prices and MPG have proportional effects on driving

- Summary
  - Objective: estimate effect of fuel economy on miles traveled, all else equal
  - Hard to distinguish short run and long run

What are the Estimates?

- Fairly wide range of estimates using both approaches
  - Usually summarize results as elasticity of VMT to fuel economy
  - Most estimates fall into range of 0.1 to 0.3; long run estimates tend to be larger
  - Some evidence for a recent decrease

- Estimated and actual cost effectiveness are pretty sensitive to the rebound effect
  - EPA/NHTSA use 0.1 as a baseline in regulatory analysis, and perform sensitivity analysis
  - Implications for many other policies (Cash for Clunkers, subsidies for electric vehicles)

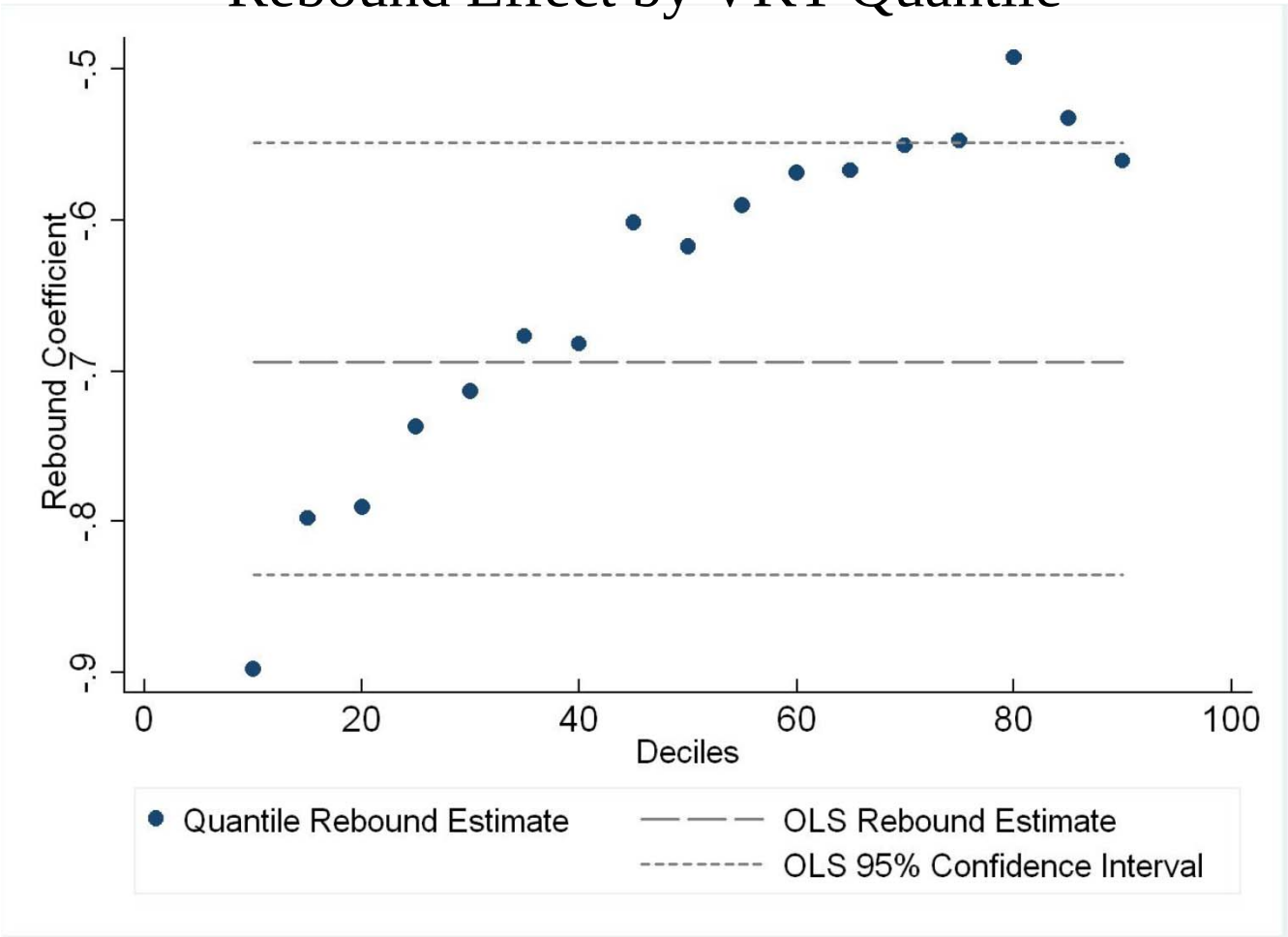
Open Questions

- Heterogeneity
  - Consumers may vary a lot in how they respond
  - This affects overall rebound effect and distributional consequences of CAFE

- What's behind the rebound effect and what does the future hold?
  - What explains the recent decrease in the rebound effect and will it continue?
  - Urban vs. rural gasoline demand and public transportation
  - Changes in living/working patterns
  - Use of electric vehicles

Rebound Effect Heterogeneity: Evidence from Germany

Rebound Effect by VKT Quantile



Source: Frondel et al. (2010)

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