HDV Technology Diffusion: Economic Trade-offs, Market Acceptance, and Policy Implications

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Reducing Energy Use and Emissions from the Freight Sector: Technical and Operational Advancements Related to Heavy-Duty Vehicles

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Overview

- Acceptance of new HDV technologies: Who decides?
- Vintage-dated regulation and fleet turnover
- Acceptance of new technologies: the “energy paradox”
- Future customer acceptance of more fuel-efficient MD/HD trucks and engines
- Policy implications and conclusions

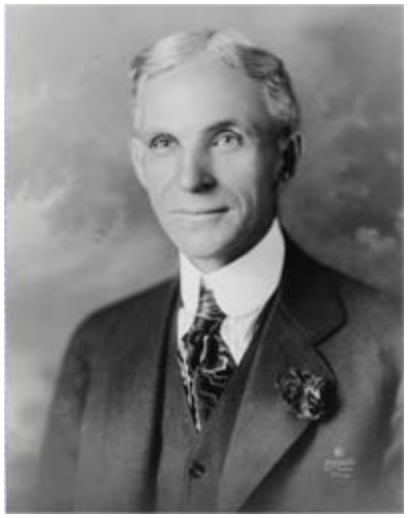
Market acceptance: Who decides what is produced and purchased?

- Producer sovereignty: Producers/regulators
- Consumer sovereignty: Customers

Producer sovereignty

"Any customer can have a car painted any color that he wants so long as it is black."

– Henry Ford



"Build it and they will come."

– Field of Dreams

Consumer sovereignty

"The number of people who will not go to a show they do not want to see is unlimited."

– Oscar Hammerstein II

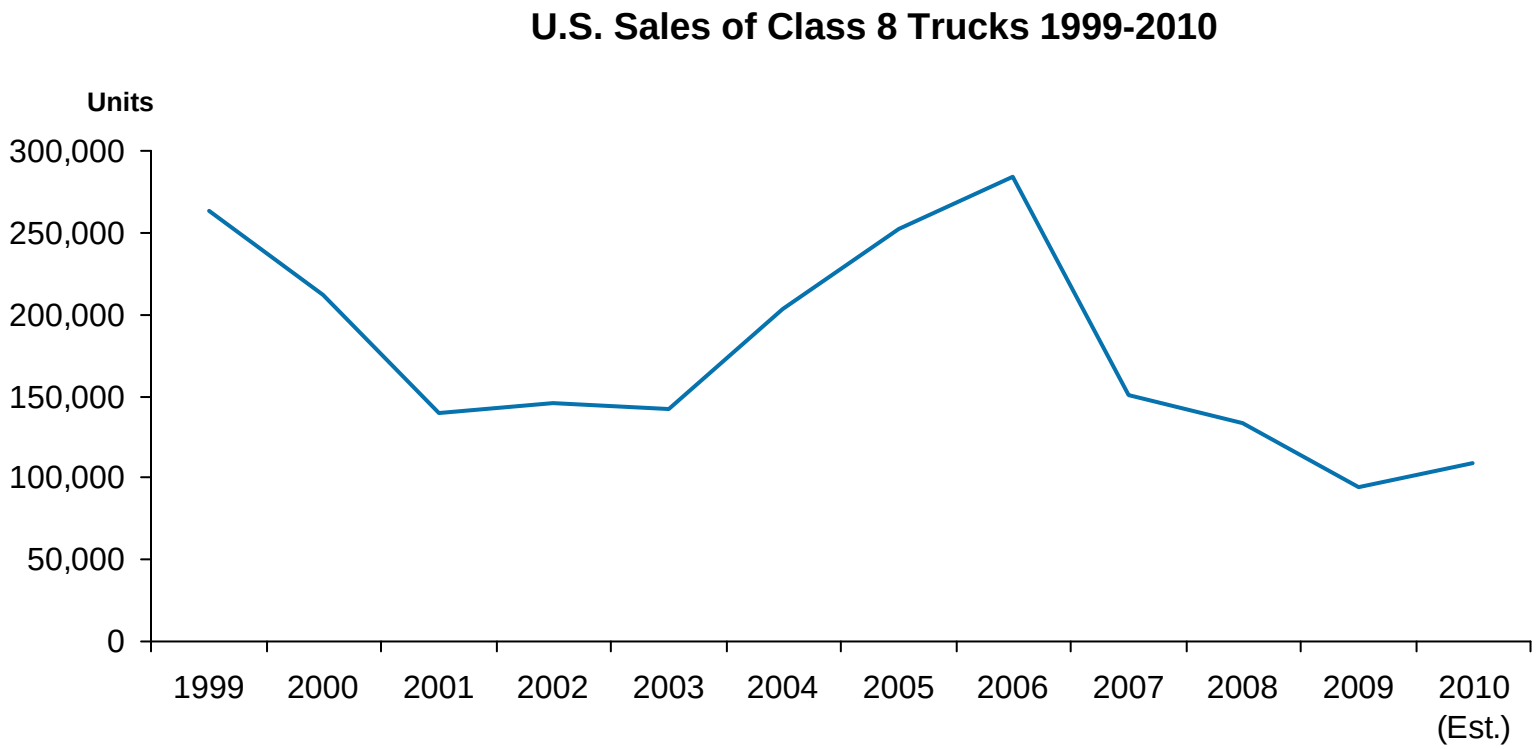
Absolute producer sovereignty requires an absence of competitive alternatives

- Once in effect, fuel efficiency standards will constrain competition among manufacturers of new trucks and heavy duty engines
- Standards will not eliminate competition from pre-existing stock of vehicles or pull-ahead sales

Vintage-differentiated regulation

- More stringent standards are applied only to newly purchased or installed equipment, while existing equipment is “grandfathered”
- Potential buyers substitute old assets for new and turnover of older, more polluting assets is slowed
  - Delayed retirement
  - Pull-ahead sales

2007 HD engine emissions standards induced pull-ahead truck sales



Will regulation of MD/HD truck fuel efficiency do the same?

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Technology adoption and the “energy paradox”

- Agencies: Technology to improve fuel efficiency should generally pay for itself quickly

Estimated payback periods for proposed MY 2018 standards (7% real discount rate)	
Truck type	**Months**
Heavy-duty pickups and vans	58
Vocational trucks	9
Tractors	8

- “Energy paradox”: Limited customer demand for fuel-saving features that seemingly should pay for themselves

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What underlies the energy paradox for MD/HD trucks?

- Agencies advance arguments classified into five “hypotheses”
  - Imperfect information in new truck markets
  - Imperfect information in truck resale markets
  - Split incentives
  - Uncertainty about future fuel cost savings
  - Adjustment and transactions costs

What underlies the energy paradox for MD/HD trucks?

- Potential explanations can also be placed into four broad categories
  - Systematic undervaluation of future cost savings
  - Market failures
  - Market frictions
  - Unmonetized economic costs

Do purchasers of energy-consuming goods undervalue future energy savings?

- Mixed evidence to support this view with respect to household purchases of consumer durables (autos, appliances)
- Less persuasive as an explanation for choices made by profit-maximizing firms
  - NRC Study: “Larger fleets will often change engine, transmission, tire, or even OEM selection to save 1 or 2 percent in fuel use.”

Market failure: Information externalities

- Early adopters that develop real-world experience base bear costs and risks
  - First movers at a disadvantage; late adopters can “free ride” on knowledge gained
  - Marketplace incentives to develop and to share real world experience are inadequate
- Can be partially offset by information sharing initiatives: e.g., “SmartWay” program
  - Efforts to develop and share information complicated by truck buyer heterogeneity

Market frictions: Split incentives

- Separate parties pay for fuel and equipment
  - This division of responsibilities may make good economic sense
  - Split may create inadequate incentives to invest in future fuel savings
- Factors in owner/driver relationships mitigate effects of split incentives
  - Fuel costs a large fraction of total lifecycle costs of owning and operating a truck
  - Labor market responses should serve to align incentives

Additional economic costs of adoption

- Adjustment and transaction costs
  - Driver (and mechanic) training
  - “Look and feel” adjustments
  - Other transition costs
- Risk aversion and uncertainty about future operating cost savings
  - Fuel consumption
  - Price of fuel
  - Maintenance expenses
- Differing use patterns and preferences between initial and resale buyers

Cited hypotheses cannot explain claimed extent of shortfalls

- Payback period of eight or nine months is too short for resale market to matter
- Expected benefits to initial owner large enough to overcome split incentives, adjustment costs, and realistic uncertainties about future cost savings
- Need to consider additional sources of unmonetized costs
  - Performance tradeoffs (opportunity costs)
  - Unknown reliability

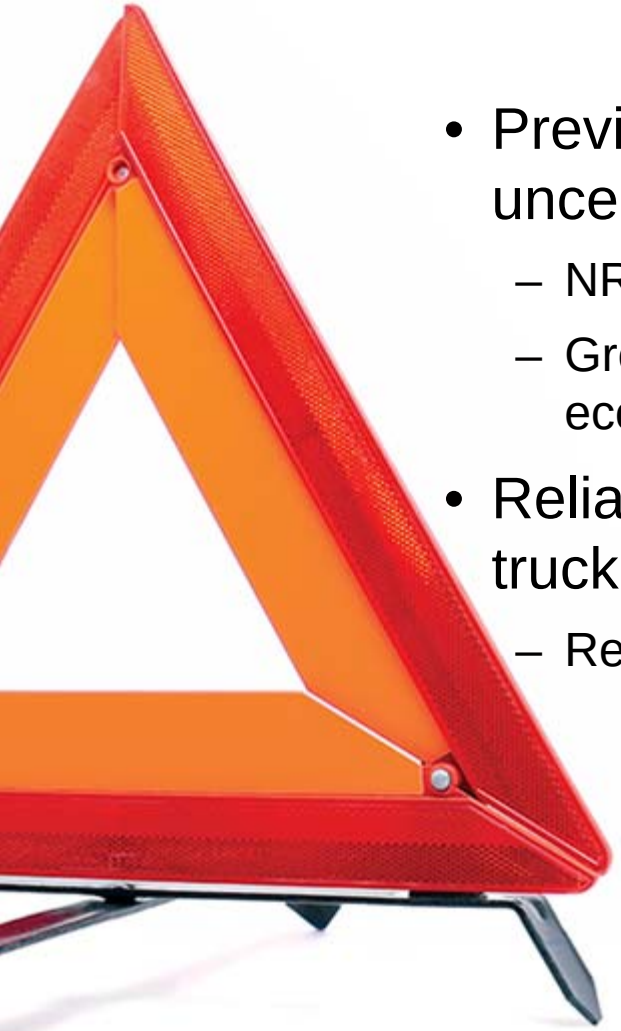
Performance trade-offs

- Proposed standards are designed to allow high-level measures of utility (power, torque, load capacity) to remain unchanged
- Trade-offs of other dimensions of utility and performance are not precluded
- Regulations may tilt trade-offs in directions that the marketplace has so far not accepted (opportunity costs)

Example: Low rolling resistance tires for vocational trucks

- Buyers place a higher value on tire traction and durability than on fuel economy performance
  - Agencies: “The drive cycles typical for [vocational] applications often lead truck buyers to value tire traction and durability more heavily than rolling resistance.”
- Agencies’ response: “Incentivize” adoption of low rolling resistance tires through standard setting
  - Agency standards assume manufacturers will be successful in overriding established customer preferences
  - Is this a valid assumption?
- Do other technologies that will be needed to meet the proposed standards also compromise utility?

Uncertain reliability



- Previous work highlights the importance of uncertainty about reliability in purchase decisions
  - NRC study
  - Greene, German, and Delucchi (2009) paper on LDV fuel economy
- Reliability likely to be larger concern for HD/MD truck buyers than for LDV buyers
  - Reliability costs could dwarf fuel savings

Fuel efficiency standards and fleet turnover: EPA/NHTSA perspective

"Build it and they will come"

- Vocational vehicles
  - Technology costs will likely be modest
  - Small price increases will not affect turnover
- Class 7 and Class 8 tractors
  - Price increases will be more significant for tractors than for vocational trucks
  - Fleet turnover effects acknowledged to be uncertain, but Agencies are planning as if there will be none
- "Without additional information . . . the Agencies are not projecting a change in fleet turnover characteristics due to this regulation."

A contrary view: customer preferences will slow adoption of engines and trucks meeting the proposed standards

"The number of potential truck buyers who will not purchase trucks and engines they do not want is greater than zero."

- None of the factors impeding customer acceptance will disappear spontaneously
- Customer resistance will persist until relevant barriers are addressed or eliminated
  - Pull-ahead sales and delayed retirements are a likely outcome of attempts to regulate fuel efficiency

Policy responses

- Address market failures
  - Create and disseminate reliable information on in-use performance
  - Subsidize early information creation through early adoption credits
- Economic costs cannot be eliminated, but some can be mitigated
  - Governments cannot make costs disappear
  - Offsetting subsidies may play a role in the transition
  - Flexible regulatory regime should reduce the costs of regulatory compliance
    - ABT provisions
    - Early adoption credits
    - “Off-cycle” emissions credits

Conclusions

- Regulators cannot assume that truck buyers will passively accept regulation-compliant engines and vehicles
- Need to identify and better understand the sources of buyer resistance
  - Address those elements that can be mitigated by policy interventions
- Acknowledge that delayed turnover effects are likely, and plan accordingly

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