The Effects of Heavy-Duty Vehicle Fuel Economy Standards

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Motivation

- The transportation sector is the largest contributor to US greenhouse gas emissions (28% as of 2018)
- Trucks are < 10% of vehicles on the road, 20% of transport CO₂ emissions
- Fuel efficiency regulations were only imposed recently (announced in 2011, implemented in 2014), virtually no ex post research exists on truck policies

Research Questions

- What is the effect of recent truck fuel economy standards on consumer welfare, manufacturer profits, fleet attributes and safety, environmental damages?
- Are there heterogeneous consequences for different buyers or manufacturers?

Empirical Setting

Truck Characteristics

- Vehicles characterized by gross vehicle weight rating
- Heavy duty trucks (class 7 and 8) can be combination tractors or vocational vehicles
- Buyers also care about: presence of sleeper cab, roof height, axle configuration, fuel intensity...

Market

- Truck manufacturers: 8 firms, producing 11 brands in the data
- Truck buyers: use trucks for widely varying commercial purposes (especially freight)


Data

- Annual sales data by model, 2009-2019
- Truck model attributes
- Fuel efficiency from fuel tracking website
- State-level manufacturing wages from BLS, plant assembly location from VINS
- Industry-level employment from County Business Patterns

Research Questions

- Policy had indirect effects on safety, road damage via GVW
- Future work:
  - Additional counterfactual simulations of alternative policy specifications (uniform policy, mpg-based policy)
  - Environmental damages

Model/Estimation

Buyer $i$ chooses truck $j$ to maximize utility $U_{i,j} = x_j(\beta_x + \sum_{ind} 1(i \text{ in } ind) \beta_{x,ind} + \beta_{x} \text{ fuel intensity}) + p_j \beta_p + \xi_j + \epsilon_{i,j}$

Firm $f$ chooses prices to maximize profits and comply with policy $\max_{\{p_{j,f}\}} \sum_{j \neq f} \left[ (p_j - m_{c_j})q_j(p) + \sum_{r} \lambda_r q_j(p) L_{j,r} \right]$ $m_{c_j}$: marginal cost
$q_j$: quantity
$\lambda_r$: shadow cost of policy on regulatory group $r$

$\rightarrow$ Derive marginal cost function using FOCs $m_{c_j} = \alpha + \gamma X_{i,j} + \omega_{i,j} + g_{f,r}(\epsilon_j)$

$\omega_{i,j}$: time-truck specific error term
$g_{f,r}(\epsilon_j)$: firm-group-specific shadow cost that depends on vehicle fuel intensity, policy timing

Counterfactual Simulations

Re-solve for market equilibrium in the absence of policy

Results

Supply and demand estimates:

- Under policy, consumers worse off and manufacturer profits increase
- Compensating variation: $27 - $47M
- Increased profit: $4-$6B

Findings and Next Steps

- Truck fuel economy standards benefited many manufacturers
- Consumers, esp. sanitation and construction buyers, were made worse off because it was harder for these buyers to switch to alternative vehicles
- Policy had indirect effects on safety, road damage via GVW
- Additional counterfactual simulations of alternative policy specifications (uniform policy, mpg-based policy)
- Environmental damages