ECE 398GG – ELECTRIC VEHICLES

14. *Light Vehicle Policy*

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The goal: clean the air

Problem of air pollution from automobile emissions:

- **How to solve?** Facilitate new technology

Policy strategies in technology development

- ☑ Standards
  - Technology Forcing (TF) - Clean Air Act

is a strategy where a regulator specify a standard that can not be met with existing technology, at least at an acceptable cost

  - Regulatory - Corporate Average Fuel Economy or CAFE

standard can be achieved with cost-effective or nearly cost-effective tech. innovations

- ☑ Incentives - Tax credits, Department of Energy (DOE) grants, purchasing (Government fleet purchases)

1970 Clean Air Act

- The Clean Air Act (CAA) is the comprehensive federal law that regulates air emissions from stationary and mobile sources.
- 1970 CAA mandated 90% reduction in tailpipe emissions over 4-5 years: TF
- TF delivers new innovations, but risks and challenges

Gerard, David, and Lester B. Lave. "Implementing technology-forcing policies: The 1970 Clean Air Act Amendments and the introduction of advanced automotive emissions controls in the United States." *Technological Forecasting and Social Change* 72.7 (2005): 761-778.

TF: risks and challenges

- Targets are too hard to achieve ⇒ need intermediate steps of progress
- Industry could push back saying technology is impossible to achieve ⇒ competitive pressure from foreign companies
- Uncertain strategy with no guarantees of a technological breakthroughs

Gerard, David, and Lester B. Lave. "Implementing technology-forcing policies: The 1970 Clean Air Act Amendments and the introduction of advanced automotive emissions controls in the United States." *Technological Forecasting and Social Change* 72.7 (2005): 761-778.

CAFE

Manufacturers can still sell heavy or luxury cars, just need to balance with high mpg

- The CAFE legislation regulates the average fuel economy of new vehicles sales in US
- It establishes required fuel economy for the entire fleet of new vehicles (in *mpg*), with separate standards established for passenger cars and light trucks.
- Vehicle manufacturers are required to have average fuel economy that meets or exceeds these fuel economy targets or pay a penalty.

Griffin, W. M., B. A. Saville, and H. L. MacLean. "Ethanol use in the United States: status, threats and the potential future." *Global Bioethanol* (2016): 34-62.

Arguments against CAFE

"does fuel economy actually save fuel"?

- The rebound effect: higher efficiency means lower cost per mile. Therefore, people will drive more, nullifying the fuel savings from efficiency

How big it is?

Depends on elasticity of gasoline consumption (0.1-0.2) → 80%-90% of max. potential reduction in fuel consumption even after ↑ in vehicles miles due to lower per mile cost

- Lighter vehicles are less safe

↳ a degree to which consumers change their demand in response to price changes: elast. 0 – demand doesn't change at all

elast. 1 – % change in demand is same as % change in price

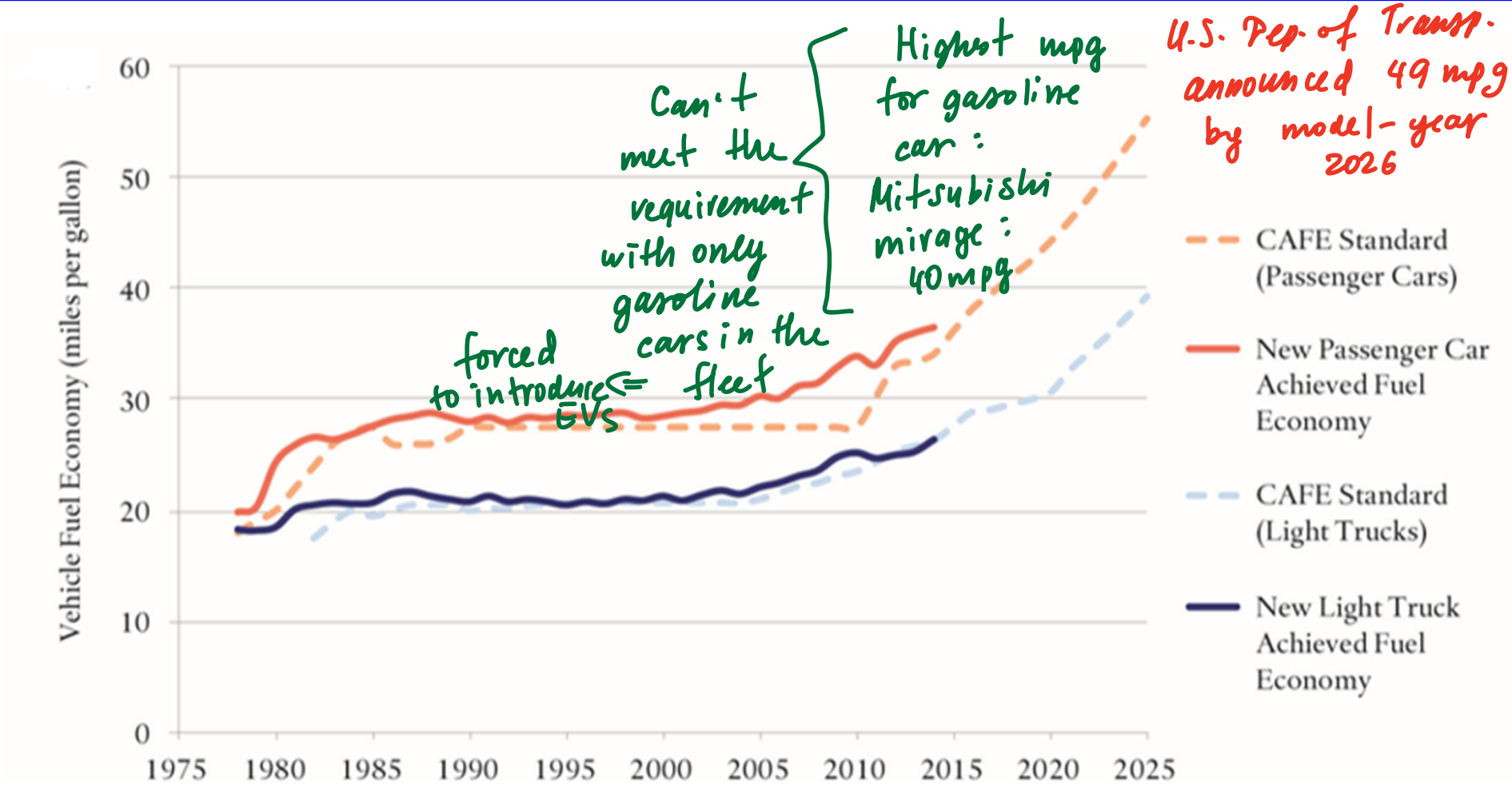
Greene, David L. "Why CAFE worked." *The Theory and Practice of Command and Control in Environmental Policy* (2018): 93-111..

CAFE worked!

- 50% increase in on-road fuel economy for light-duty vehicles from 1975 to 1995
- Would it have happened from then existing market forces? Greene: No, since net cost+benefit of fuel economy improvement is +/- $100, not enough to motivate car buyer

Greene, David L. "Why CAFE worked." *The Theory and Practice of Command and Control in Environmental Policy* (2018): 93-111..

CAFE (Corporate Average Fuel Economy)



Sivaram, Varun, and Michael A. Levi. *Automobile Fuel Economy Standards in a Lower-Oil-Price World*. Council on Foreign Relations., 2015.

CAFE: How is a manufacturer's CAFE determined for a given model year?

- Fleet fuel economy is calculated using a harmonic mean
  - For a fleet composed of four kinds of vehicle A, B, C and D, produced in numbers n_A, n_B, n_C and n_D with fuel economies f_A, f_B, f_C and f_D,

    the CAFE (in *mpg*):

$$\frac{n_A + n_B + n_C + n_D}{\frac{n_A}{f_A} + \frac{n_B}{f_B} + \frac{n_C}{f_C} + \frac{n_D}{f_D}}$$

https://en.wikipedia.org/wiki/Corporate_average_fuel_economy.

ACTIVITY:

- Manufacturer X produces 3 passenger cars models in 2006:

Model	MPG	Production Volume
A	28	150,000
B	27	50,000
C	18	10,000

- Is the manufacturer compliant with 2006 model-year CAFE standard (27.5 *mpg*)?

No, CAFE is 27mpg < 27.5mpg

ACTIVITY:

- Now suppose that manufacturer X has quit making model C and introduced a new model D in 2007:

Model	MPG	Production Volume
A	28	70,000
B	27	30,000
D	31	120,000

- Is the manufacturer compliant with 2007 model-year CAFE standard (27.5 *mpg*)?

Yes, CAFE is 29.4 mpg > 27.5 mpg

Alternative fuels: barriers to broad consumers acceptance

- Lack of refueling infrastructure
- High cost
- Lack of vehicles engineered to operate on the fuel
- Difficulty breaking into an established market
- Perceived or real issues of safety and reliability
- Lack of driving range

McNutt, Barry, and David Rodgers. "Lessons learned from 15 years of alternative fuels experience—1988 to 2003." *The hydrogen energy transition*. Academic Press, 2004. 165-179..

Lessons from alternative fuels (1988 - 2003 policies)

- Range limitation and slow refueling may be the most critical technical barriers
- Niche markets don't lead to mainstream consumer markets (fleets vs. consumers)
- Incremental benefits to consumers are small relative to conventional vehicle fuels (thus need policy to stimulate interest)
- Infrastructure may limit adoption; why would private sector invest? Clear stimulus from government is needed

McNutt, Barry, and David Rodgers. "Lessons learned from 15 years of alternative fuels experience—1988 to 2003." *The hydrogen energy transition*. Academic Press, 2004. 165-179..