Transportation Intro

Environmental Impact & Policy

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Intro

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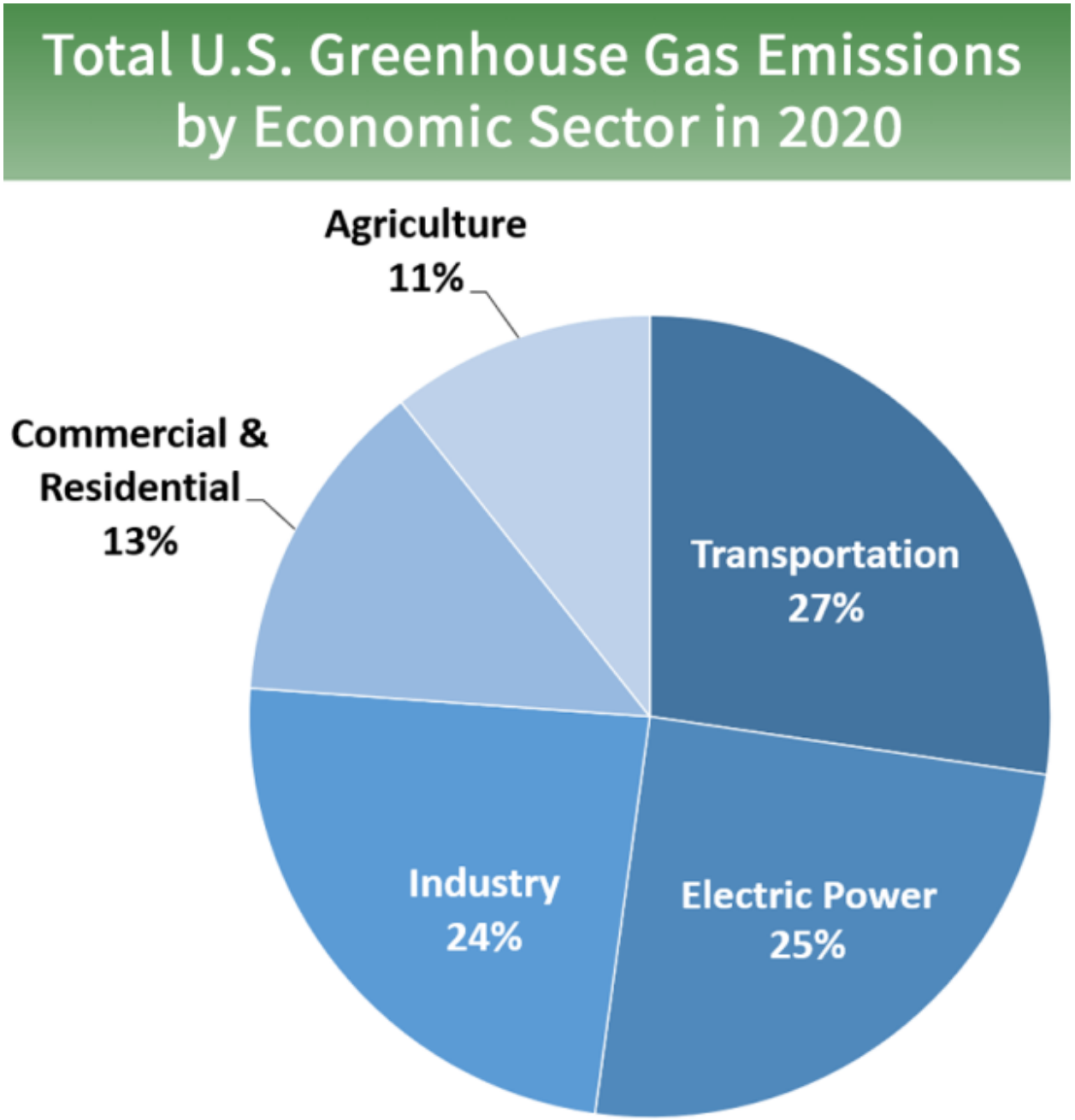
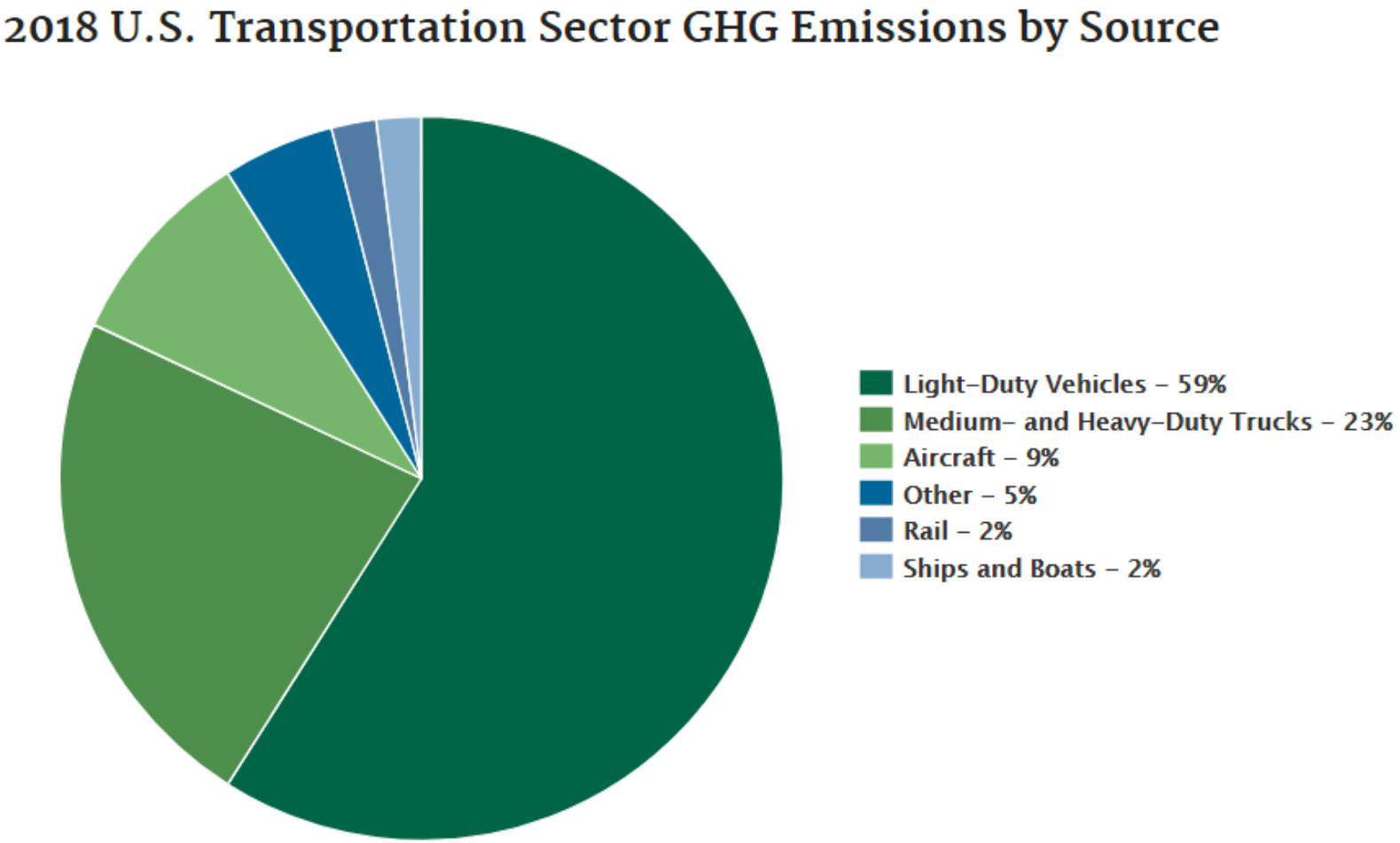
- US is by far the largest oil consumer in the world
- Petroleum associated with many externalities
- Knittel reviews four ways to reduce consumption
- Discuss how they compare
- Many of the tables today from the US Alternative Fuel Data Center

Transportation is the biggest source of US CO2



Most of that comes from cars



Compared to electricity markets, do you think it will be easier or harder to reduce CO2 emissions from transportation markets?

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How should we go about doing this? Econ 101 answer: tax the driving at the external cost.

Many other externalities associated with driving

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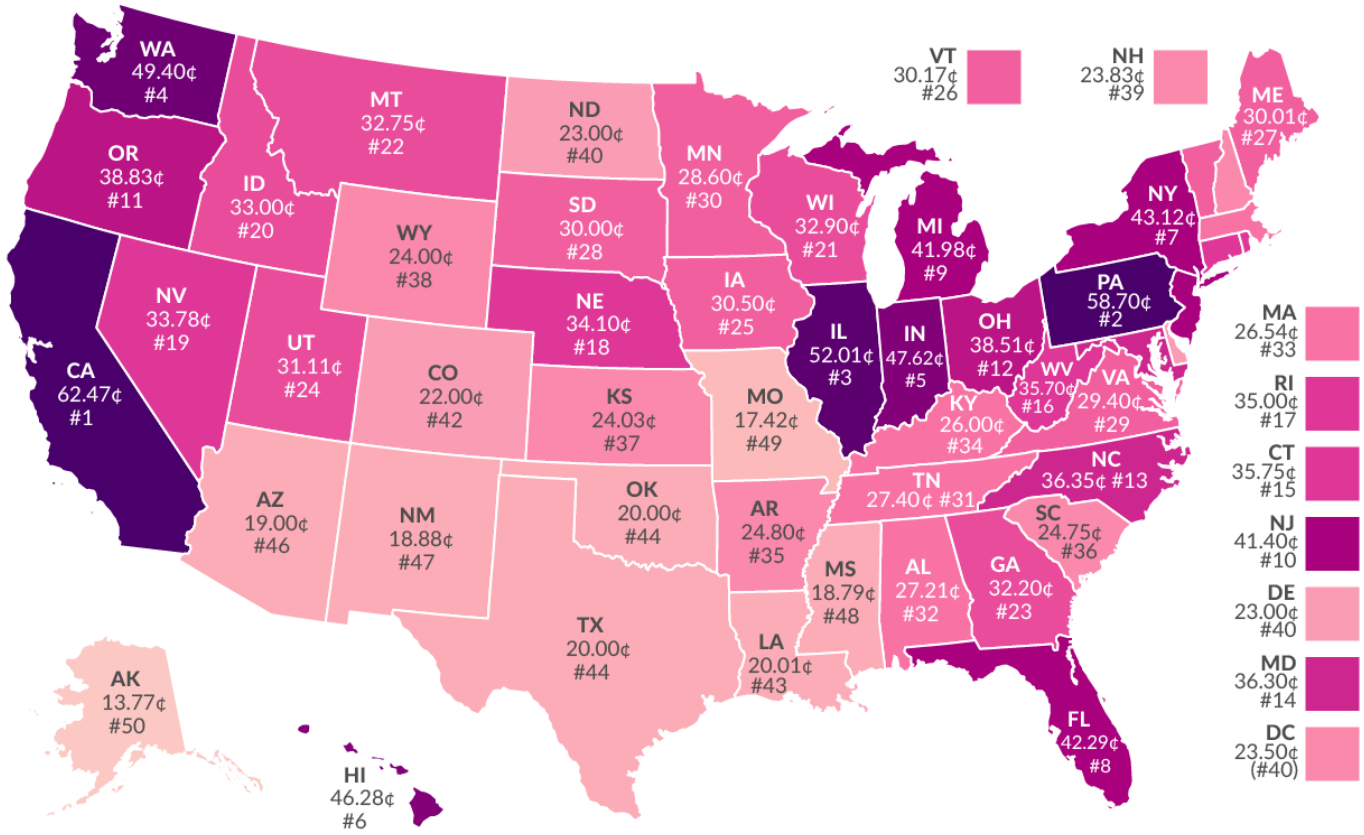
- local pollution (petroleum)
- national security? (petroleum)
- road damage (all driving)
- accident risk (all driving)
- climate change (petroleum)

All told the gas tax should be well above \$2/ gallon.

How High Are Gas Taxes in Your State?

Total State Taxes and Fees on Gasoline, July 2020 (cents per gallon)



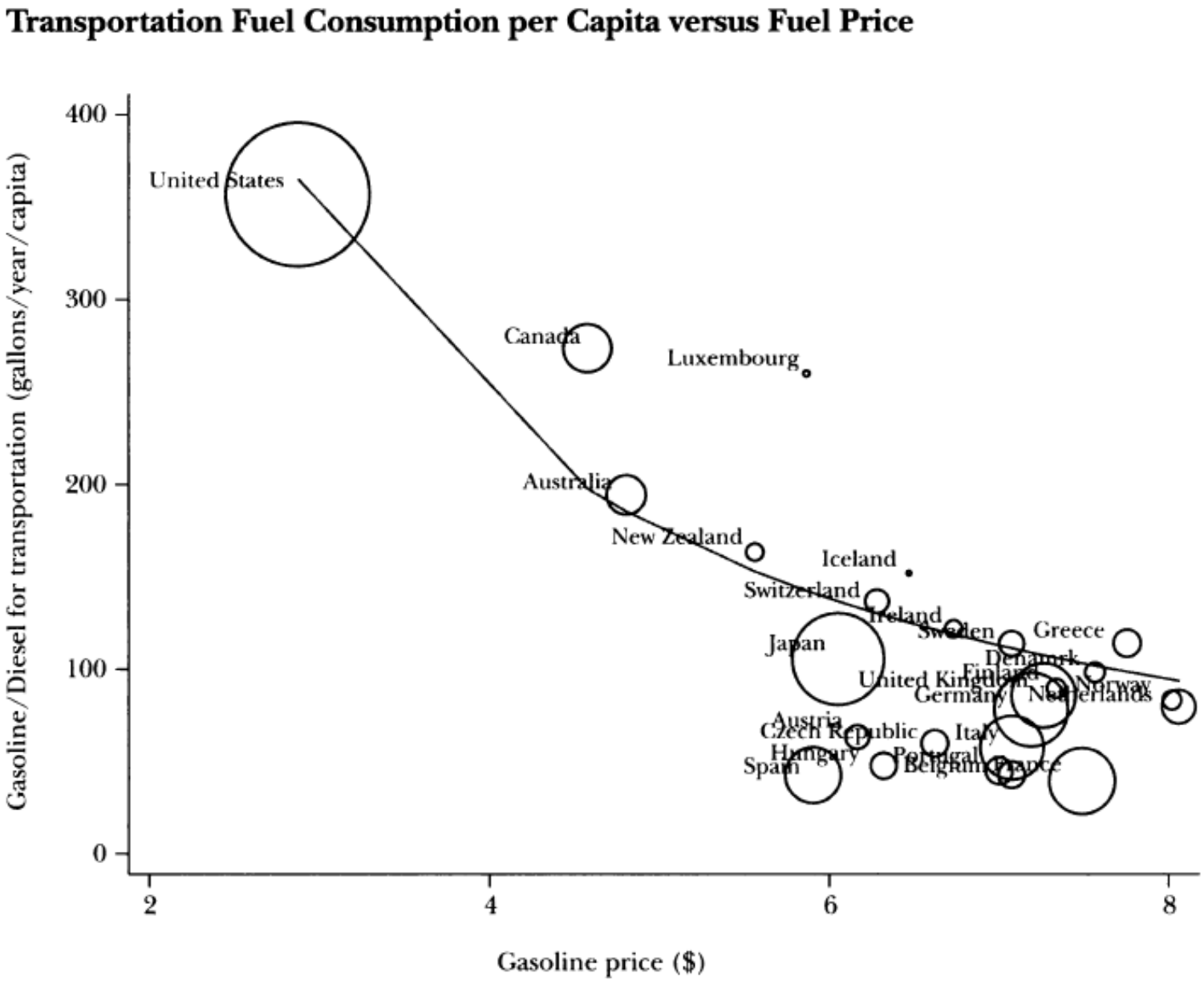
Note: These rates do not include the 18.4 cent/gallon federal excise tax rate on gas. The American Petroleum Institute has developed a methodology for determining the average tax rate on a gallon of fuel. Rates may include any of the following: excise taxes, environmental fees, storage tank taxes, other fees or taxes, and general sales taxes. In states where gasoline is subject to the general sales tax, or where the fuel tax is based on average sale price, the average rate determined by API is sensitive to changes in the price of gasoline. D.C.'s rank does not affect states' ranks, but the figure in parenthese indicates where it would rank if included. Data as of July 2020.

Source: American Petroleum Institute, "Notes to State Motor Fuel Excise and Other Taxes."

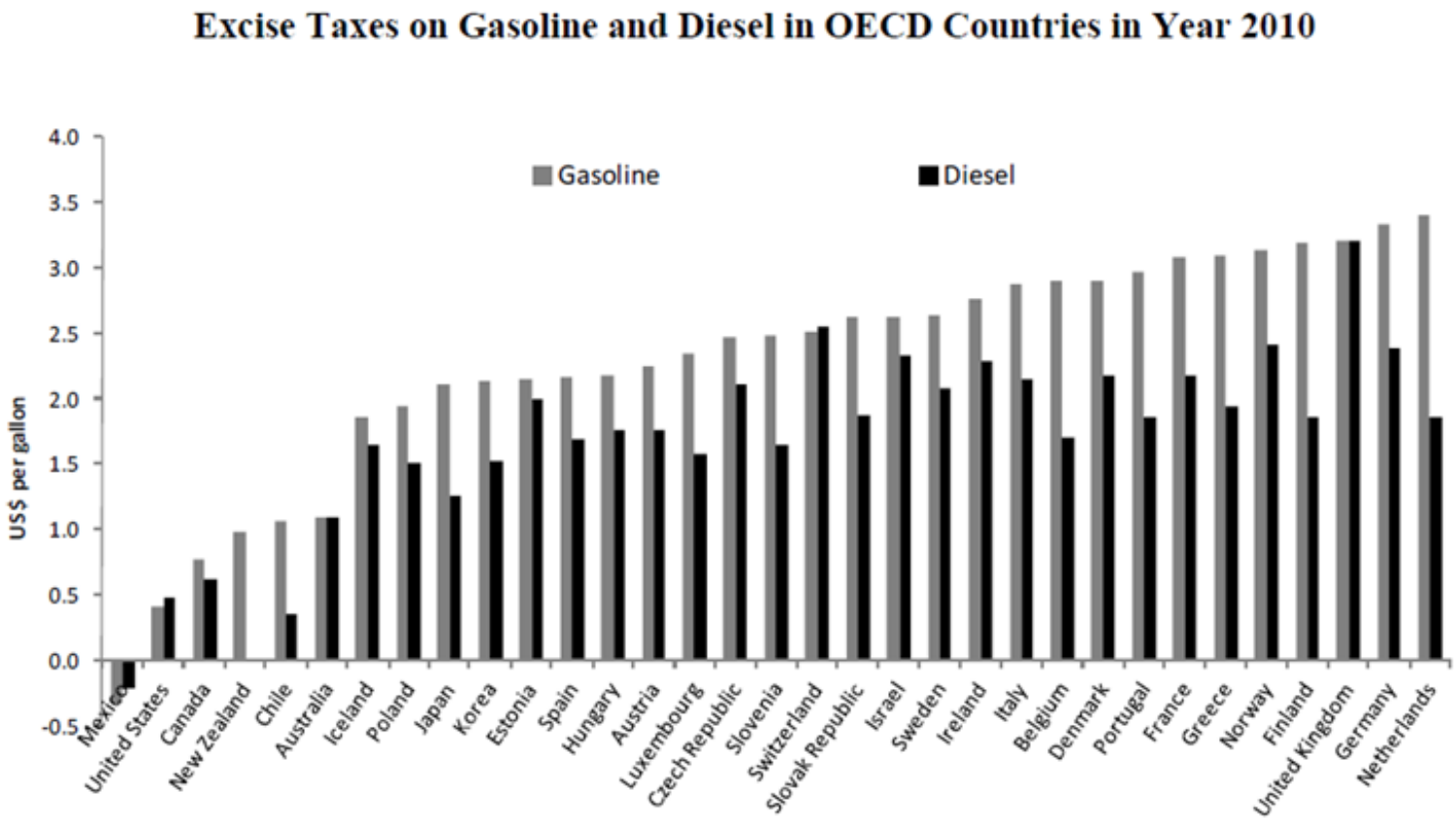
Total State Taxes and Fees on Gasoline, July 2020 (cents per gallon)

Lower — Higher

Gasoline consumption vs prices in OECD I contries

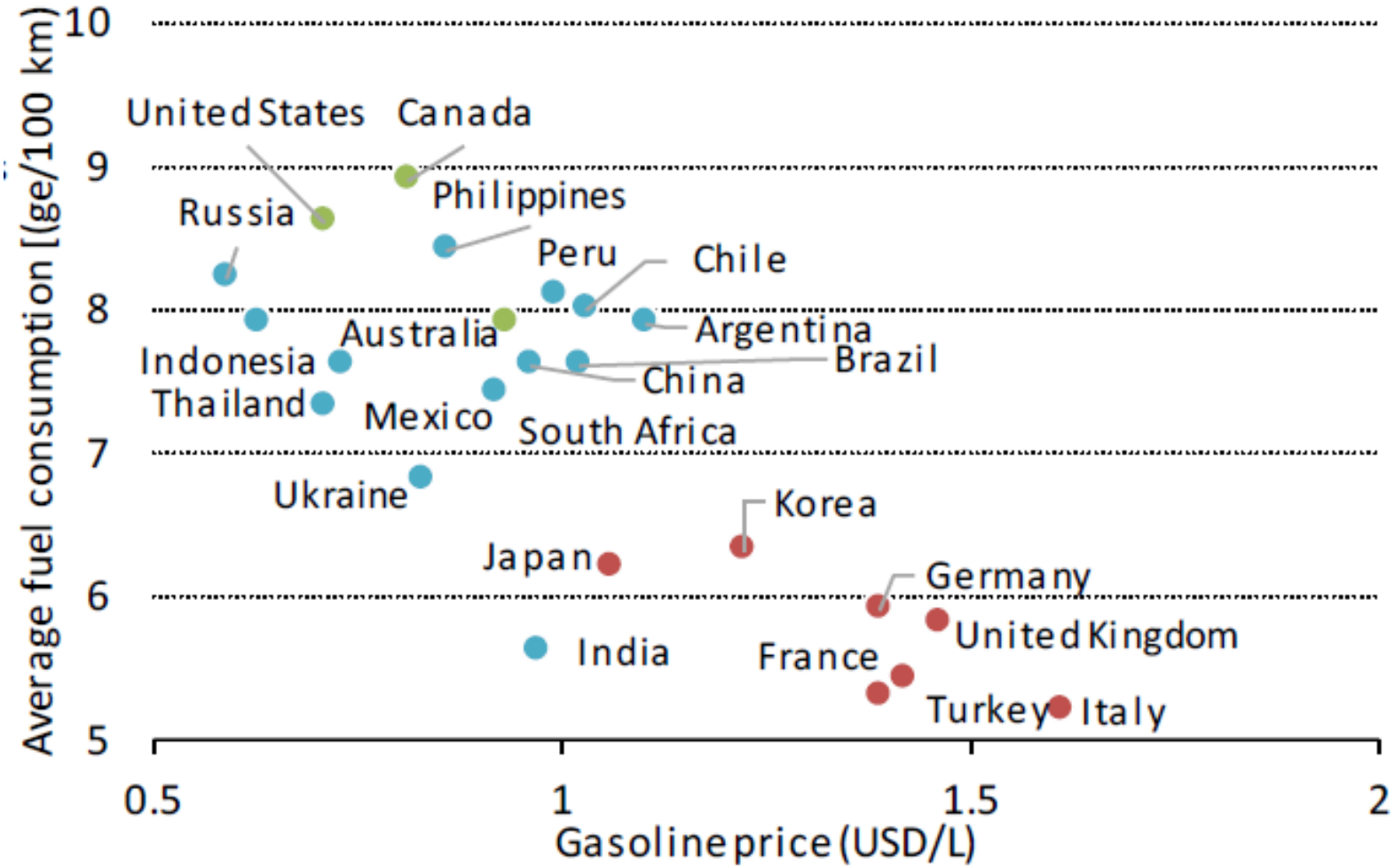


Most of the price difference across countries due to taxes/ subsidies



Source: OECD (2010), Figure 2.5.

This causes people to buy inefficient cars



Emission reduction channels

Kaya identity for cars:

$$\text{emissions} = \text{people} \times \frac{\text{miles}}{\text{person}} \times \frac{\text{fuel}}{\text{mile}} \times \frac{\text{emissions}}{\text{fuel}}$$

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What are the channels through which gasoline consumption might be reduced? (Knittel 2012)

- Increased fuel economy ($\frac{\text{fuel}}{\text{mile}}$)
- Use of alternative fuels ($\frac{\text{emissions}}{\text{fuel}}$)
- Alternatives to the combustion engine ($\frac{\text{fuel}}{\text{mile}}$ and $\frac{\text{emissions}}{\text{fuel}}$)
- Reduced driving

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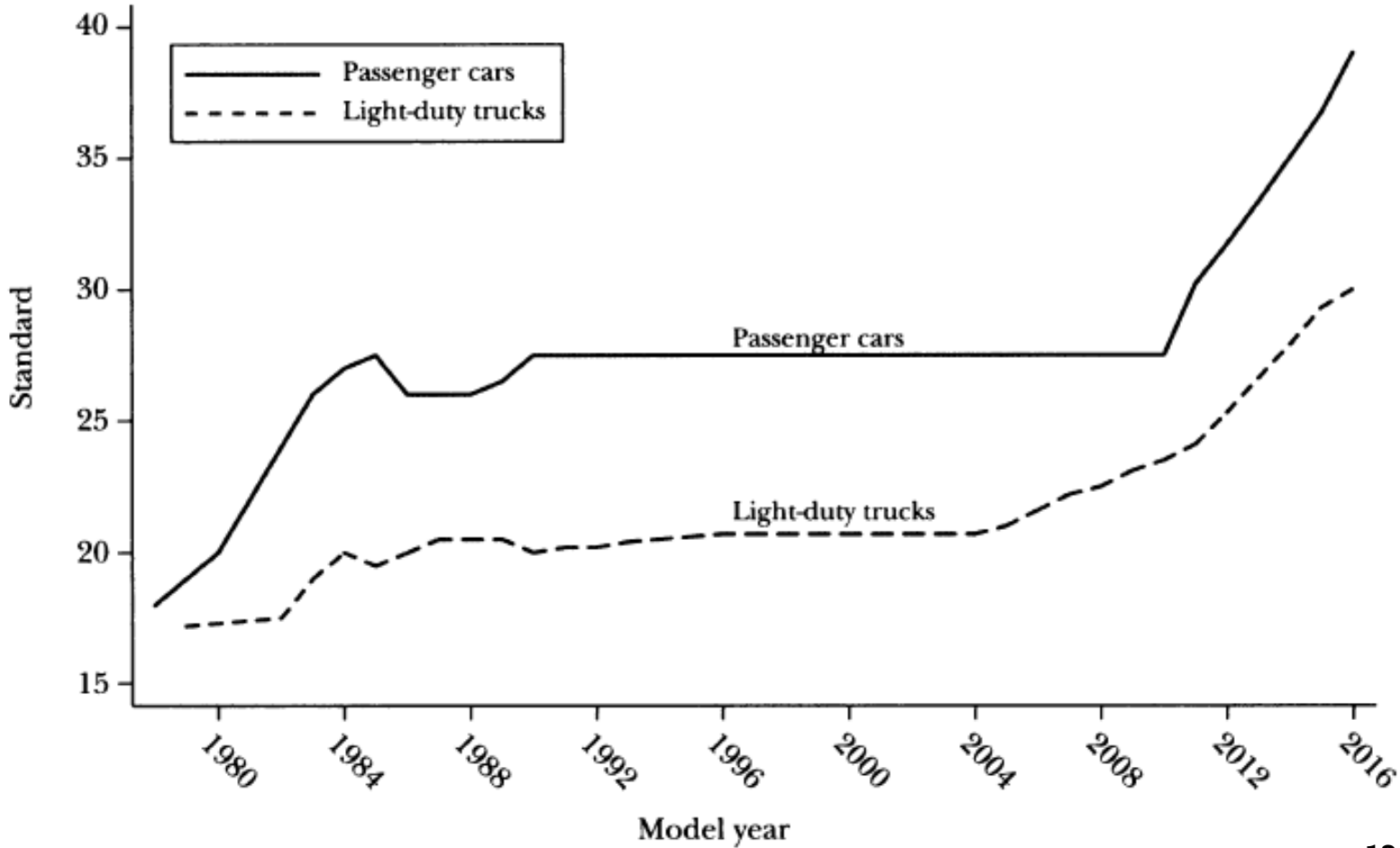
A gasoline tax would target all of these margins. Instead, policy tries to target these directly.

Fuel economy

Oil price shocks of the 1970's led US to adopt Corporate Average Fuel Economy (CAFE) Standards

- Minimum average fuel efficiency (MPG) for all new vehicles sold
- By world standards, these are not aggressive ($\approx$ 17 MPG $<$ EU)

U.S. CAFE Standards from 1978 to 2016



CAFE overview

- Mandate that across all cars sold in the US, the average fuel economy (miles per gallon) has to be above the federal mandate (currently 35.5 mpg)

- Basically acts like a quantity instrument (although an inefficient one): For every Escape SUV Ford sells, it needs to find someone to buy a Fiesta Allows for trading across firms

How does this compare to a gas / carbon tax?

Revisiting our model of adopting energy efficient technology

- Setup:
  - miles driven m fixed
  - owning a car fixed, just choose between efficient and inefficient model, based on energy use per mile (e) and up front cost (c)
- solution:

$$\gamma p m (e_I - e_E)/(1+r) - \xi < c_E - c_I$$

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- Now want to consider
  - There are *many* cars you can choose
  - Once you own a car, all that matters is cost of driving. And that will depend on e....

Thinking on the margin

Assume no inattention or other important attributes. Utility

$$u_i = y_i - p_j^{car} + \alpha_i m_{ij} - p^{gas} m_{ij} e_j$$

For each car j (and person i), there is an optimal amount of miles driven:

$$\partial u / \partial m = \alpha_i - p^{gas} e_j = 0$$

Can figure out m_{ij}^* for all j cars. Then pick the option that maximizes total utility.

Implications

- If p or m go up, more likely to buy efficient cars j
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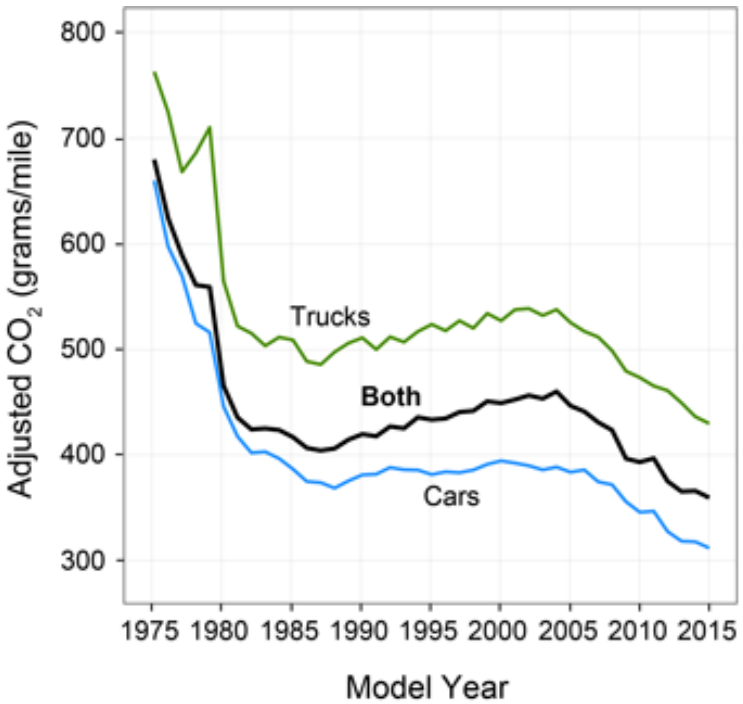
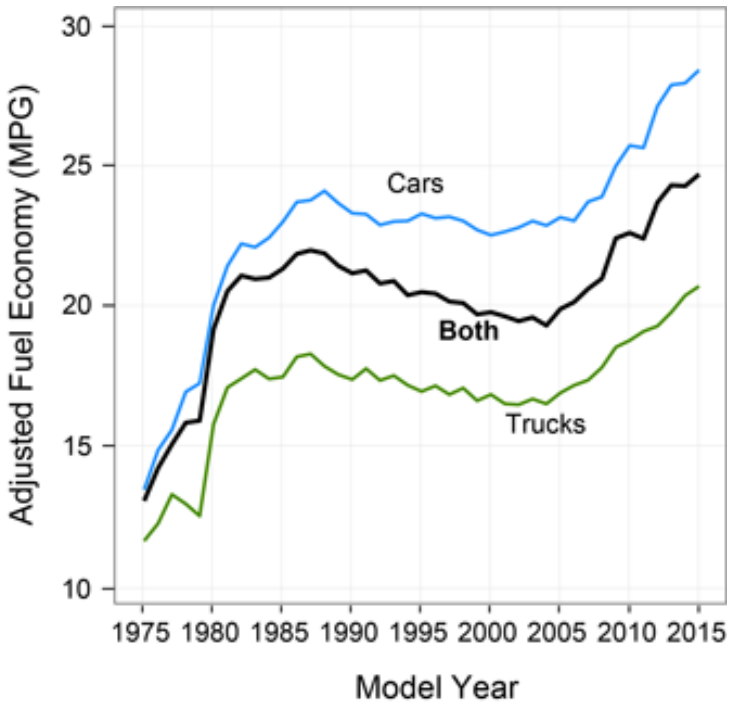
- CAFE only (directly) effects new vehicles. A tax encourages people to drive cars they already own less.
  - why is that a problem?
  - If you make new SUVs / trucks much more expensive, people will hold onto their older (less efficient) ones longer ("Grunspecht effect")

Actual US fuel economy in the US did not change for decades

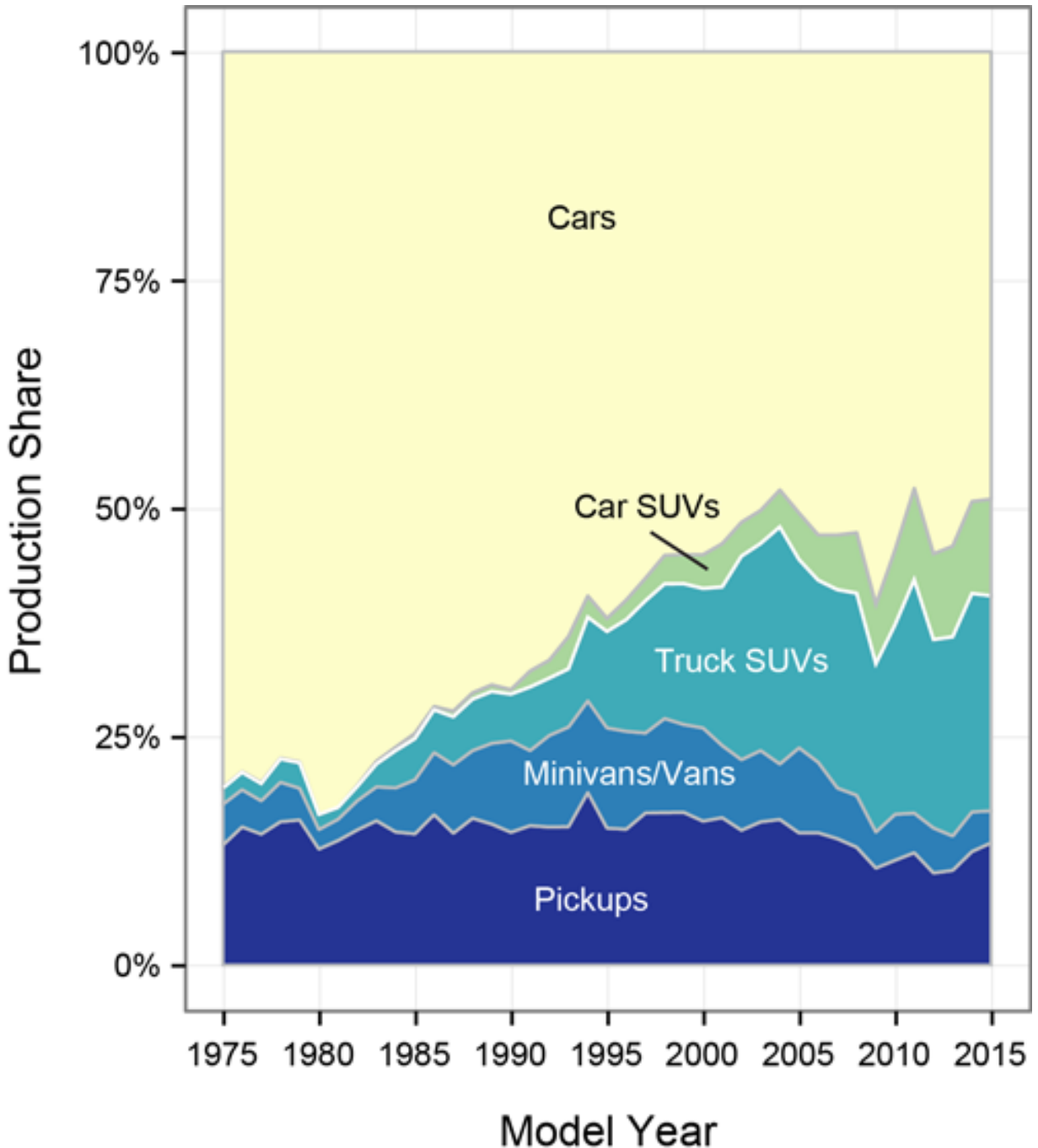




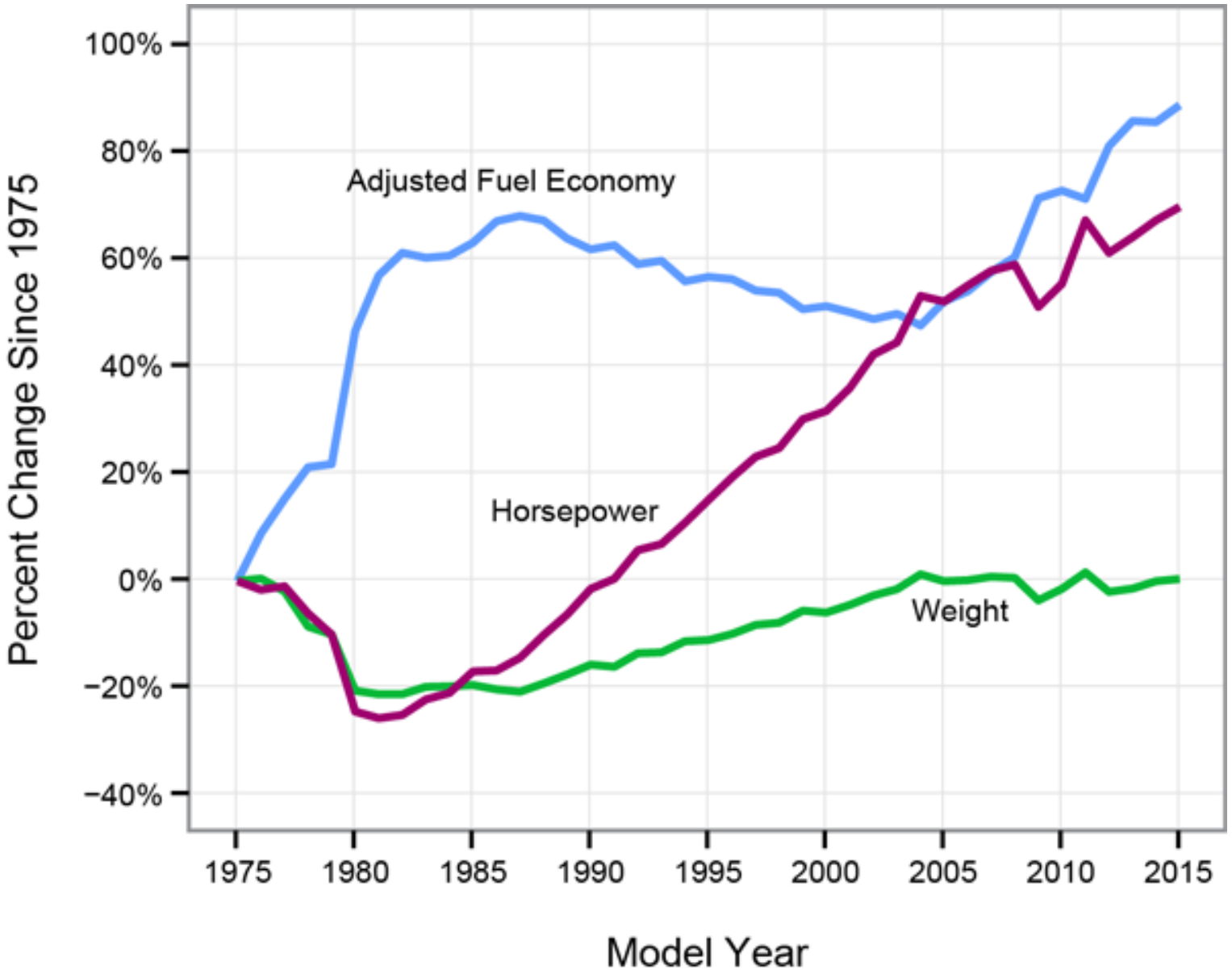
[1]Adjusted CO_2 and fuel economy values reflect real world performance and are not comparable to automaker standards compliance levels. Adjusted CO_2 values are, on average, about 25% higher than the unadjusted, laboratory CO_2 values that form the starting point for GHG standards compliance, and adjusted fuel economy values are about 20% lower, on average, than unadjusted fuel economy values that form the starting point for CAFE standards compliance.

Source: EPA Fuel Economy Trends

Fleet composition changed a lot



Raw MPG numbers don't tell the whole story



Source: EPA Fuel Economy Trends

Obama admin set new CAFE standards

- New CAFE standards took effect in 2012
- Inital standard was 34.1 MPG this year, 54.5 by 2025
- Some big changes summarized by Lucas Davis as "the good, the bad, and the ugly"
- The good: trading now exists between firms
  - Why is trading important?

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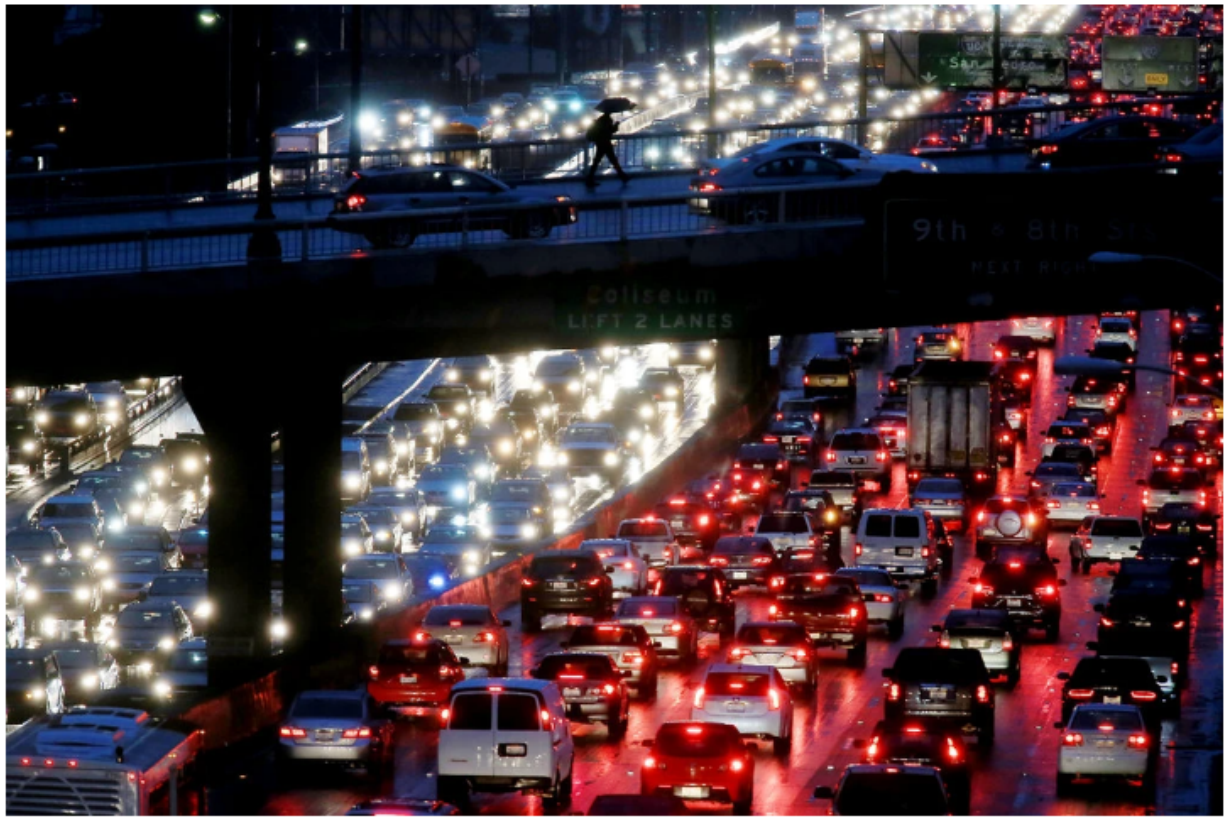
- Some big changes summarized by Lucas Davis as "the good, the bad, and the ugly"
- The good: trading now exists between firms
  - Why is trading important?
  - For companies that sold lots small, efficient cars, old standard did not effect them
- Obama admin BCA implied a large energy efficiency gap
  - "Consumer Savings Comparable to Lowering Price of Gasoline by $1 Per Gallon by 2025"

Trump rolled this back, freezing MPG at 2020 levels

E.P.A. Readies Plan to Weaken Rules That Require Cars to Be Cleaner

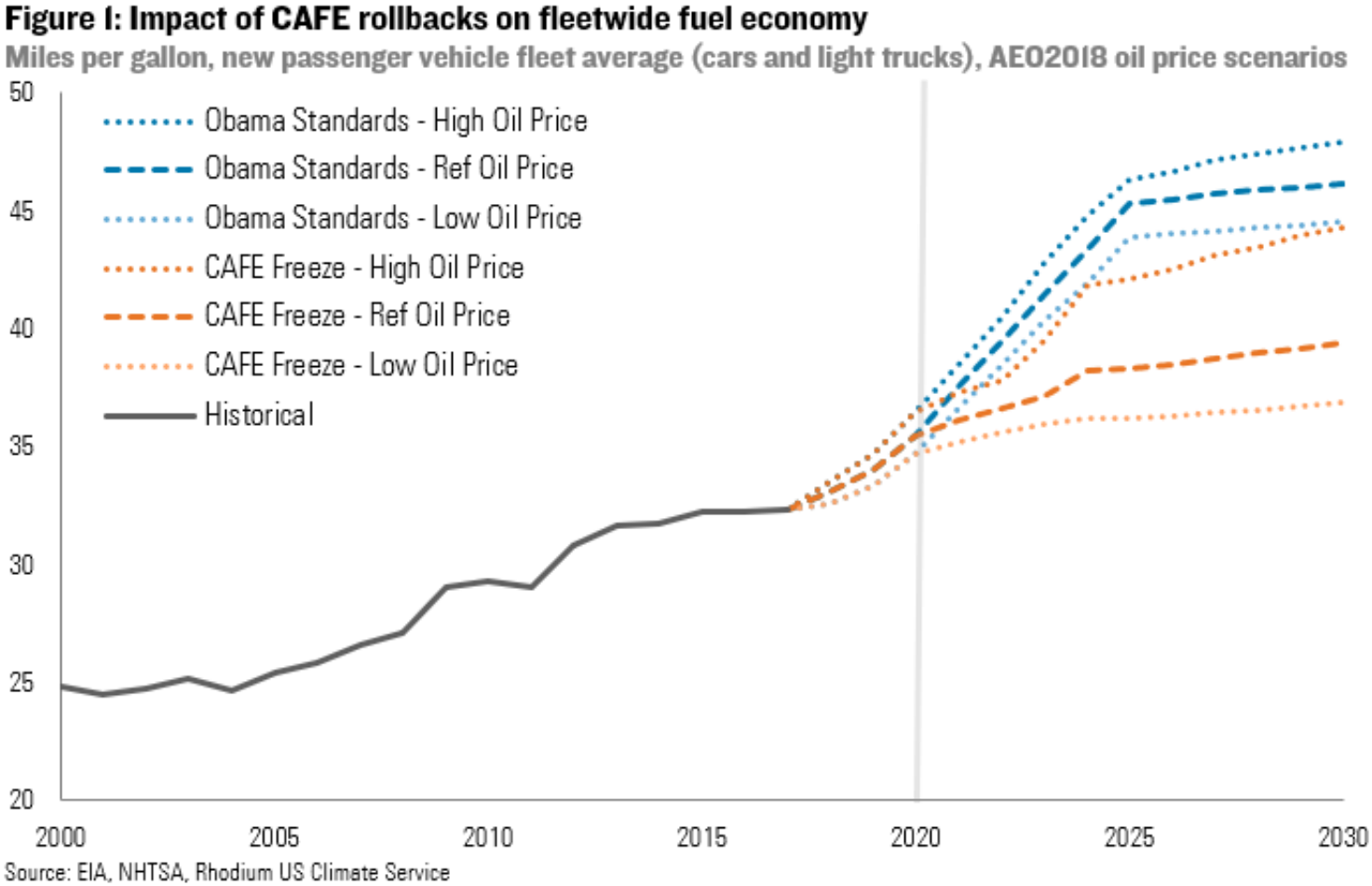


The new regulations would also challenge California's authority to set its own emissions marks, which it seeks to keep at the tougher, Obama-era standards. Luis Sinco/Los Angeles Times, via Getty Images

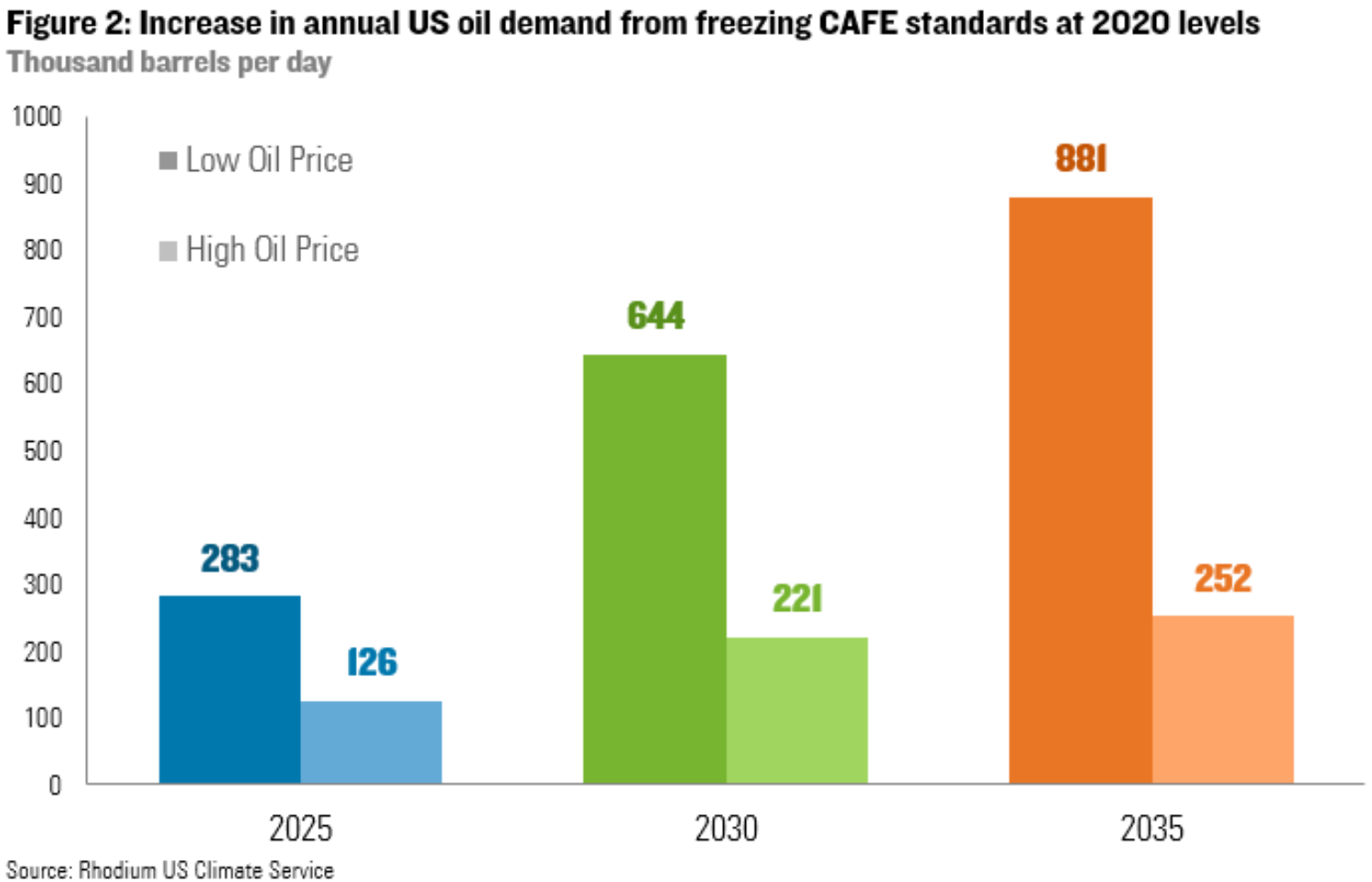


By Hiroko Tabuchi, Brad Plumer and Coral Davenport

April 27, 2018



Source: Rhodium Group



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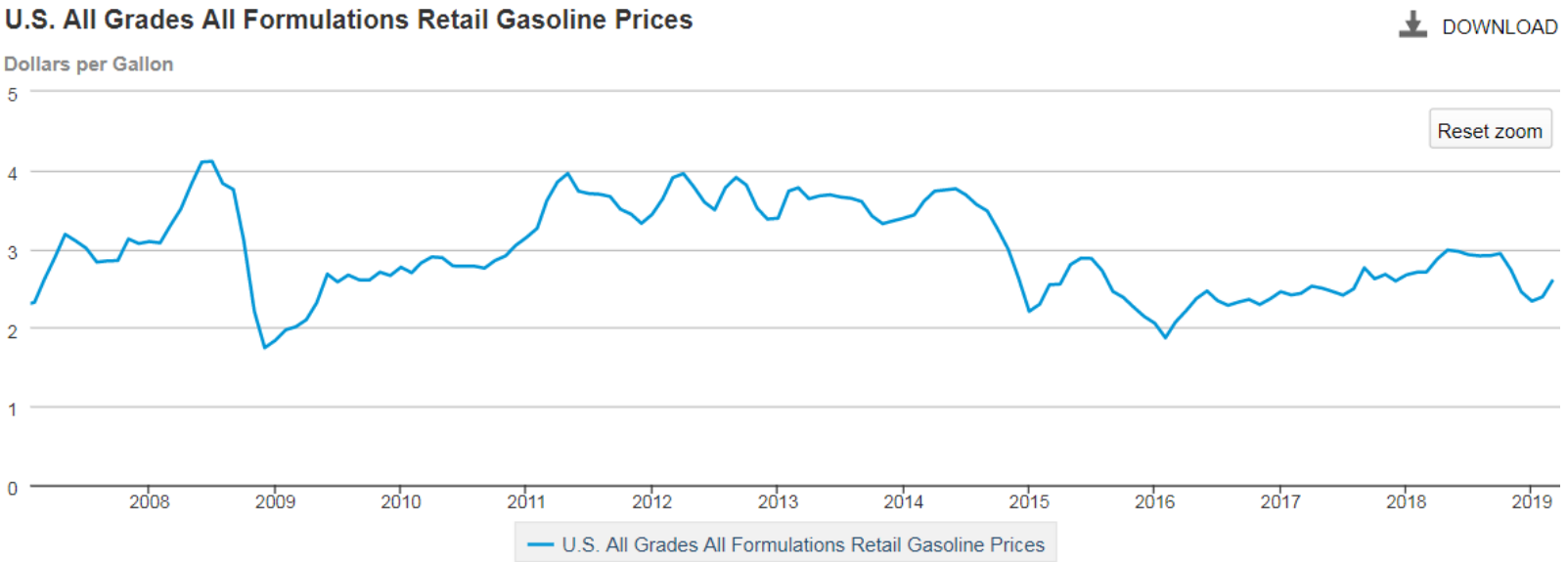
Lessons on policy stability?

- Obama promulgated change almost immediately
- New standards announced in 2012, ostensibly with broad industry support.
- Worked with automakers to allow reasonable time to plan for new strict standards



Source: EIA

Fuel Switching

What about diesel?

- Approximately 33% better gas mileage than gas
- Circa 2010 seen as a "green" alternative to gasoline
- What happened?

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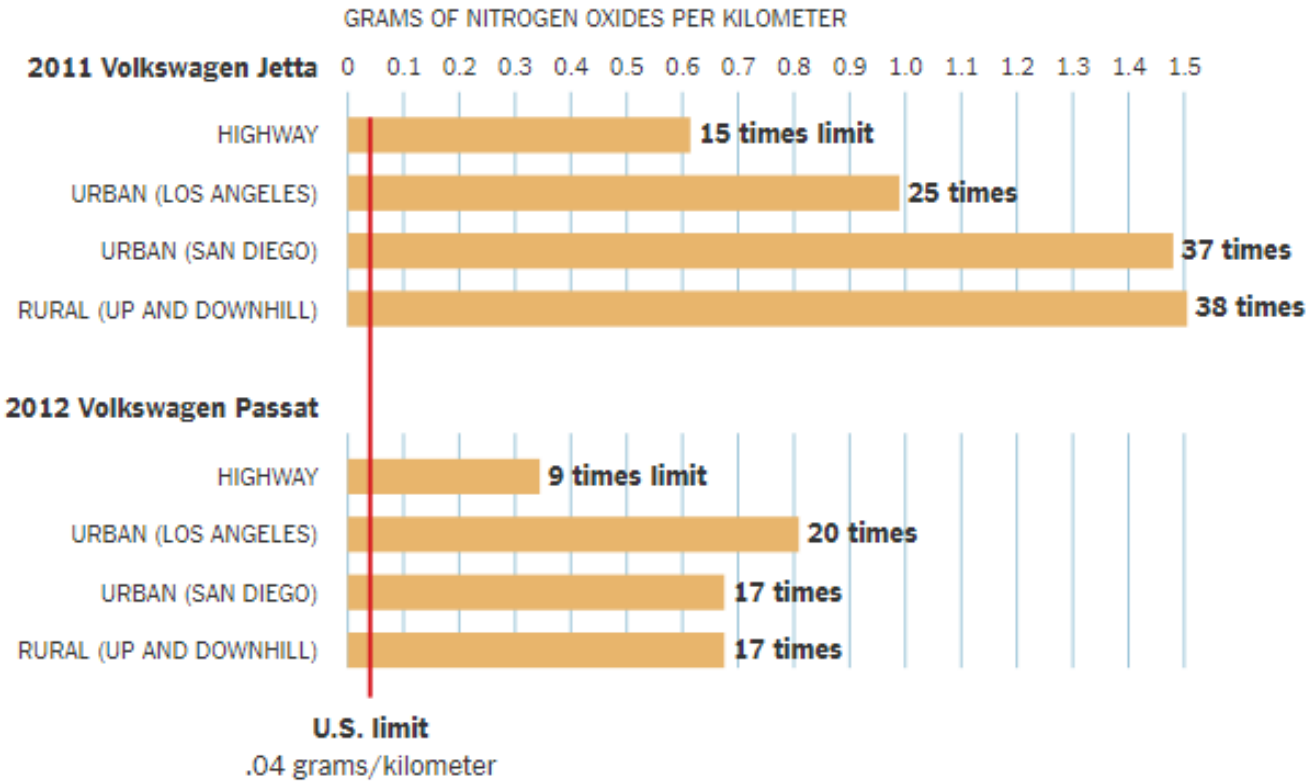
The Emissions Tests That Led to the Discovery of VW's Cheating

The on-road testing in May 2014 that led the California Air Resources Board to investigate Volkswagen was conducted by researchers at West Virginia University. They tested emissions from two VW models equipped with the 2-liter turbocharged 4-cylinder diesel engine. The researchers found that when tested on the road, some cars emitted almost **40 times** the permitted levels of nitrogen oxides.

Average emissions of nitrogen oxides in on-road testing



Source: Arvind Thiruvengadam, Center for Alternative Fuels, Engines and Emissions at West Virginia University

Alternative fuels

- One option for reducing petroleum consumption is to switch fuels
- But biofuels still result in CO2 emissions at various points in their lifecycle
- Part of this depends on the feedstock
  - corn and sugar uses lots of fertilizer and water
  - cellulosic biofuels use little
- And on how the stock is refined (wet vs dry)
- Also important to factor in indirect effects
  - In Brazil, ethanol boom caused sugarcane to crowd out grazing land
  - Cattle owners in turn cut down rainforest
  - Some research suggests this particular effect lead ethanol to actually result in more CO2 emissions than gasoline
- Unfortunately these are very hard to measure

Alternative fuels (cont)

- CARB 2011 studied this and found
  - gallon of gasoline generates 27.9 lbs C02 (19 direct)
  - Midwest ethanol was 26% *higher* (corn, wet, coal powered)
  - CA NG powered ethanol 19% lower
- EPA study: can be 13-34% higher or 26-27% lower depending on power source and refining type
- So ethanol is at best marginally cleaner.
- Is switching to ethanol even feasible?

There are also other limiting factors suggesting ethanol could not easily replace oil (in the US)

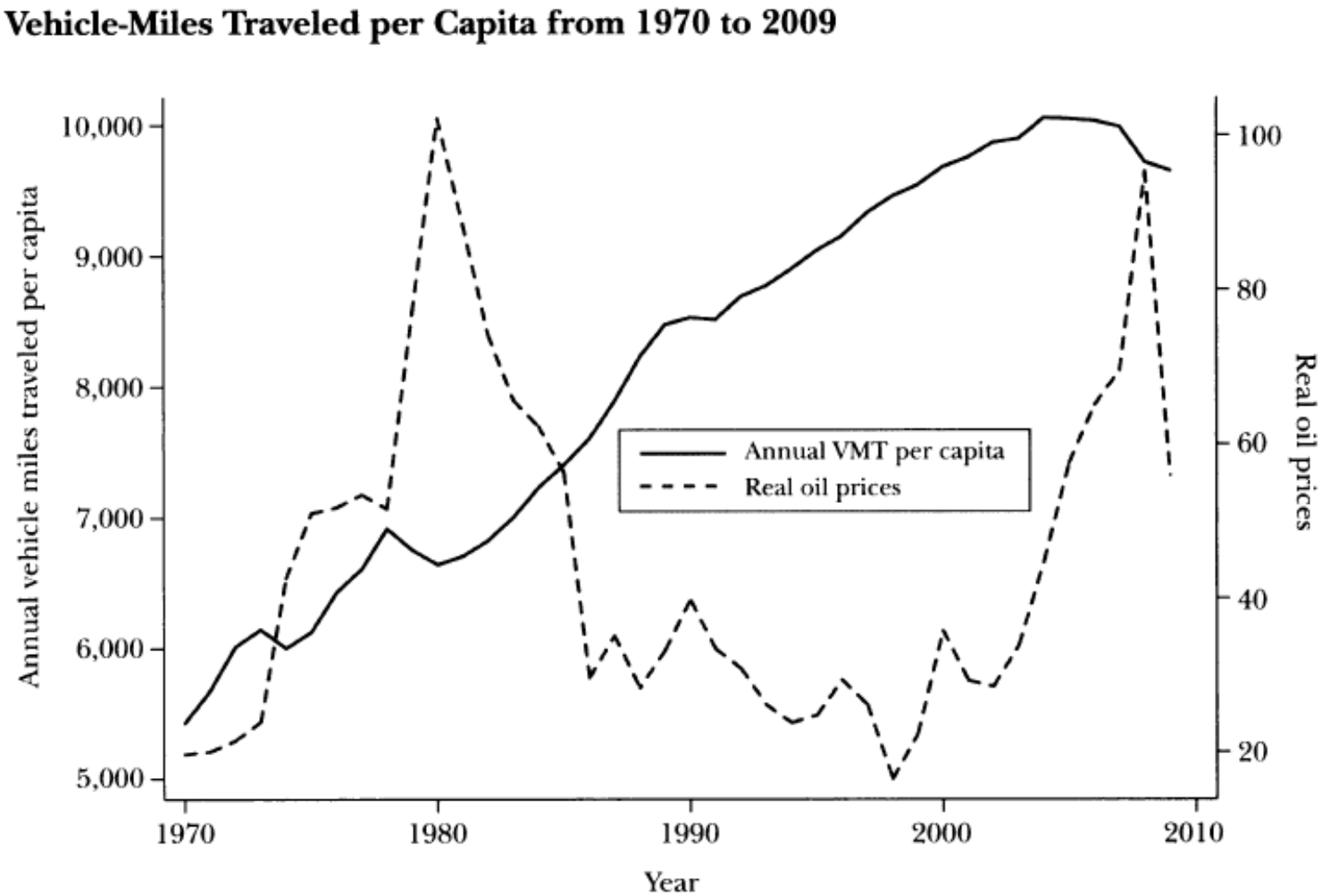
- Going from 15% ethanol to 85% would require 415 million acres of corn crop
  - only 406 total acres of farmed land in the US ...
- Short run "blend wall"
  - cars can only handle 15% ethanol
- Despite this, lots of policy promoting ethanol
  - \$0.45 (corn) - \$0.91 (cellulosic) tax credit
- The US has also had volumetric mandates since the Energy Independence and Security Act of 2007

Alternatives to the internal combustion engine

- Could use an electric motor power by either electricity or a fuel cell
  - We will spend an entire class on EVs in a few weeks
- Would be a game changer because we can power these with zero emission electricity from wind or solar
- In 2003, George W. Bush touted hydrogen cars as the future
  - Despite lots of research, could not make it economical
  - 2009 Obama killed fuel cell research funding
  - Toyota recently announced it was actively working in this area

Demand

The forgotten solution: Drive less!



Source: Knittel (2012)

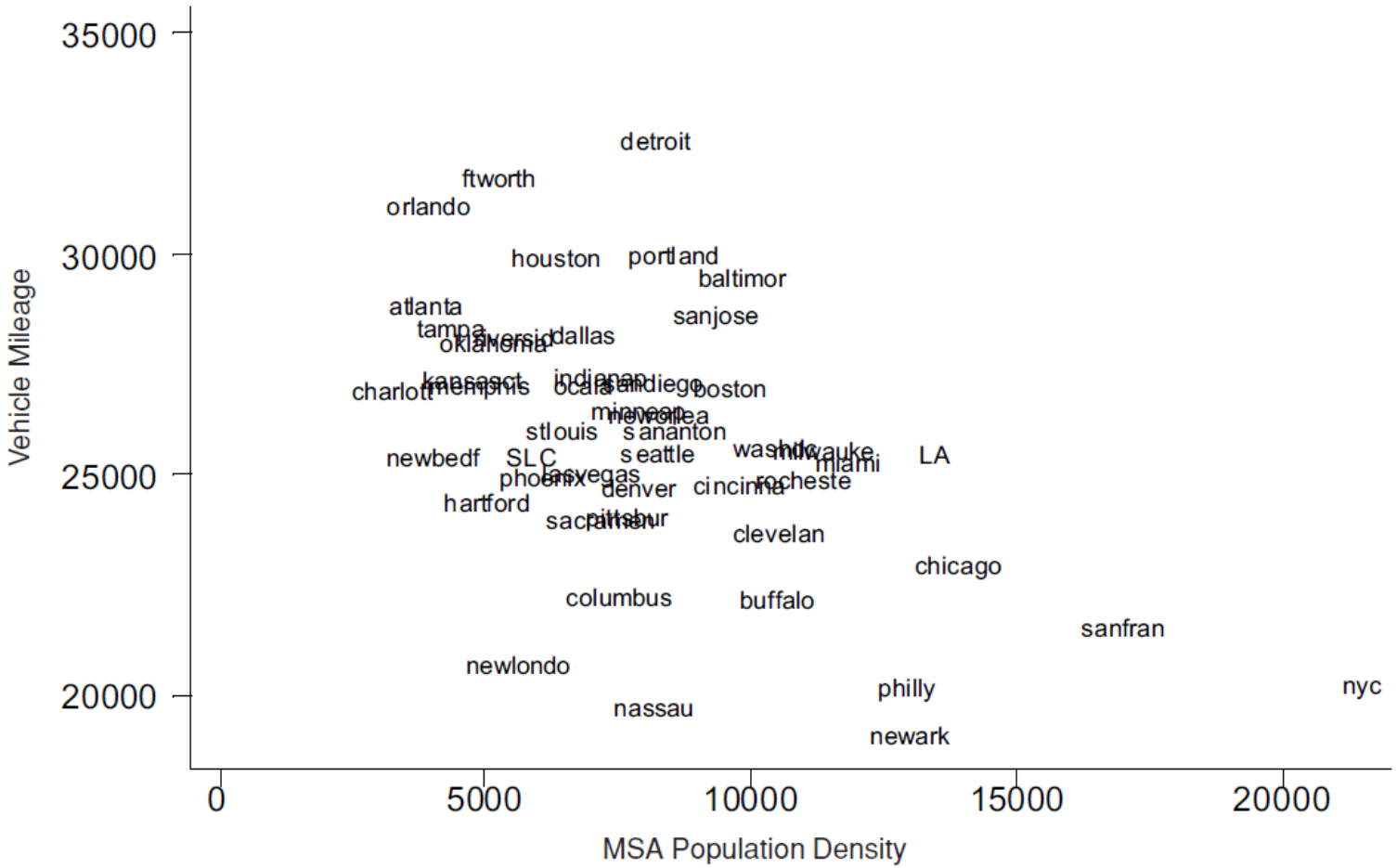
Environmental impact of suburbanization

Two dominant demographic trends in second half of the 20th century

1. Suburbanization
   - In 1950, the share of metropolitan area residents who lived in central cities was 57 percent
   - by 1990 had fallen to 36 percent (Mieszkowski and Mills, 1993)
2. Regional migration from the Rust Belt to the Sun Belt
   - In 1940, 49 percent of the nation lived in the New England, Middle Atlantic, and East North Central divisions.
   - By 1990, this area's share had fallen to 37 percent.

Households are (were?) increasingly choosing to live in low-density, vehicle-dependent suburban areas.

Vehicle mileage as a function of pop. density



Source: Kahn (2010)

Why Housing Policy Is Climate Policy

In California, where home prices are pushing people farther from their jobs, rising traffic is creating more pollution.

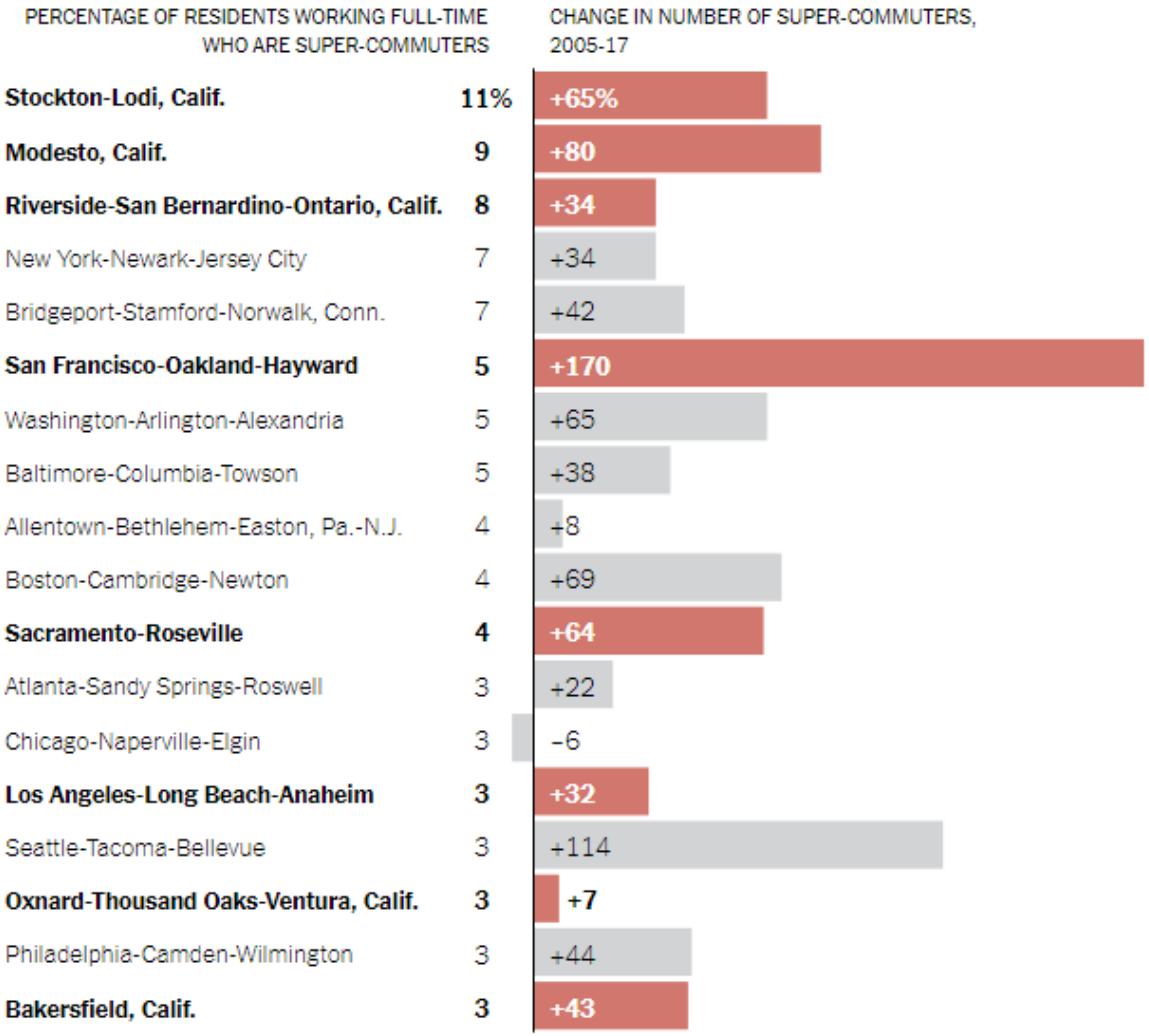
By Scott Wiener and Daniel Kammen

Senator Wiener is the chairman of the California Senate's Housing Committee. Dr. Kammen is a professor of energy at the University of California, Berkeley.

March 25, 2019

Cities With the Most 'Super-Commuters'

Of the 100 largest U.S. metropolitan areas, these are the 20 with the greatest proportion of residents working full-time who spend 90 minutes or more getting to their jobs. (Nationally, 72 percent of these super-commuters drive.) Eight of these areas are in California; the San Francisco area has seen the most growth in ultra-commuters since 2005.



By The New York Times | Source: Apartment List

How do these policies compare with a Pigouvian tax?

- Economic theory tells us that the first best would be to tax the externality directly
- CAFE and Renewable Fuel Standards are examples of performance standards
  - products better than the standard implicitly subsidized, those above implicitly taxed
- CAFE targets the wrong thing
  - BC prof who drives a Hummer from Brookline vs one driving a Prius from NH
- Current estimates suggest
  - CAFE is 2-7 times more expensive than an equivalent tax
    - using SCC, it is basically a wash
  - Estimates suggest the RFS is 3x more costly than a carbon tax (ignoring large land use changes)

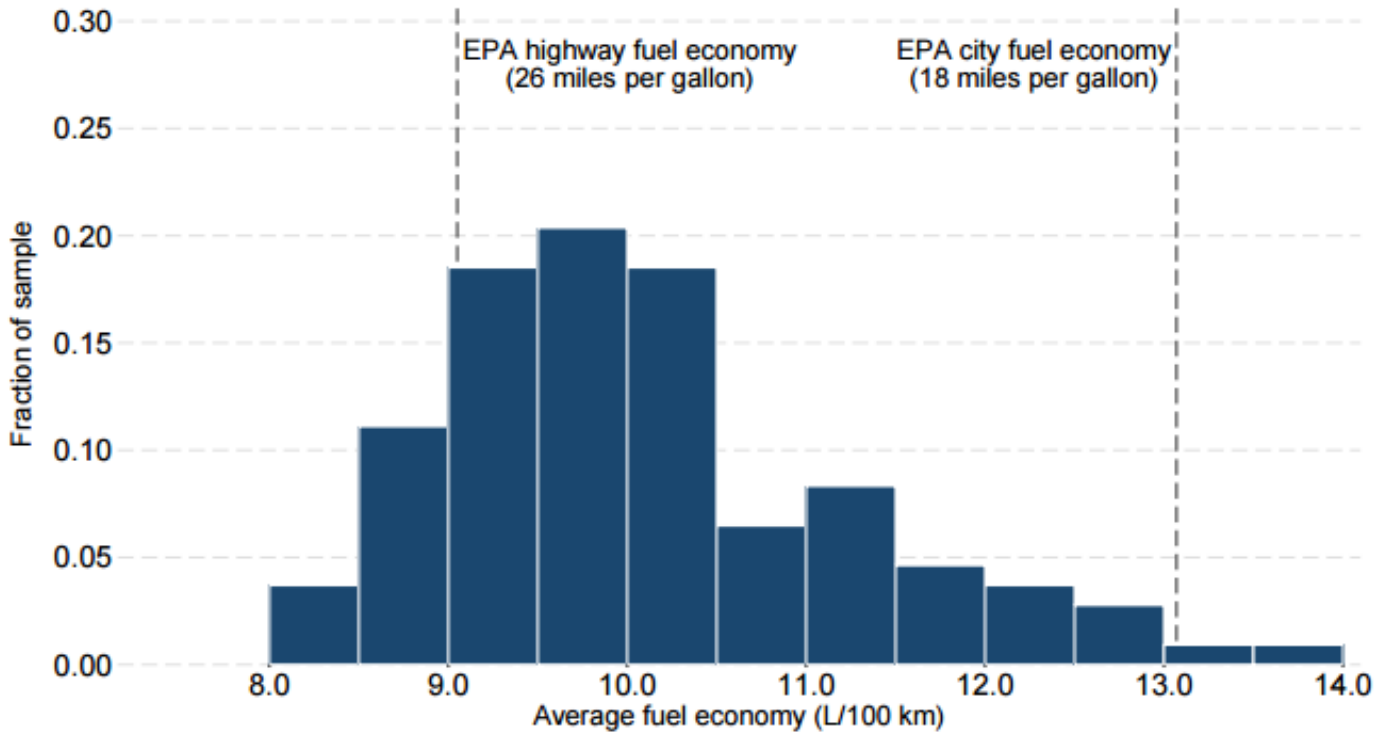
Note that in order to evaluate this, you need to know the elasticity of demand for gasoline

- Tons of papers trying to estimate this
- We will read three of these next week
- This is what the next problem set is on

Technological solution?

- many people think driver-less cars will reduce congestion
- my optimize speed, will it affect number of cars on the road?
- may also improve fuel economy?

Figure 2: Distribution of mean fuel economy across drivers



Data: 108 drivers driving identical Honda Accords for 6 weeks
Source: Langer and McRae (2015)