THE ECONOMICS OF ELECTRIC VEHICLES

DAVID RAPSON & ERICH MUEHLEGGER

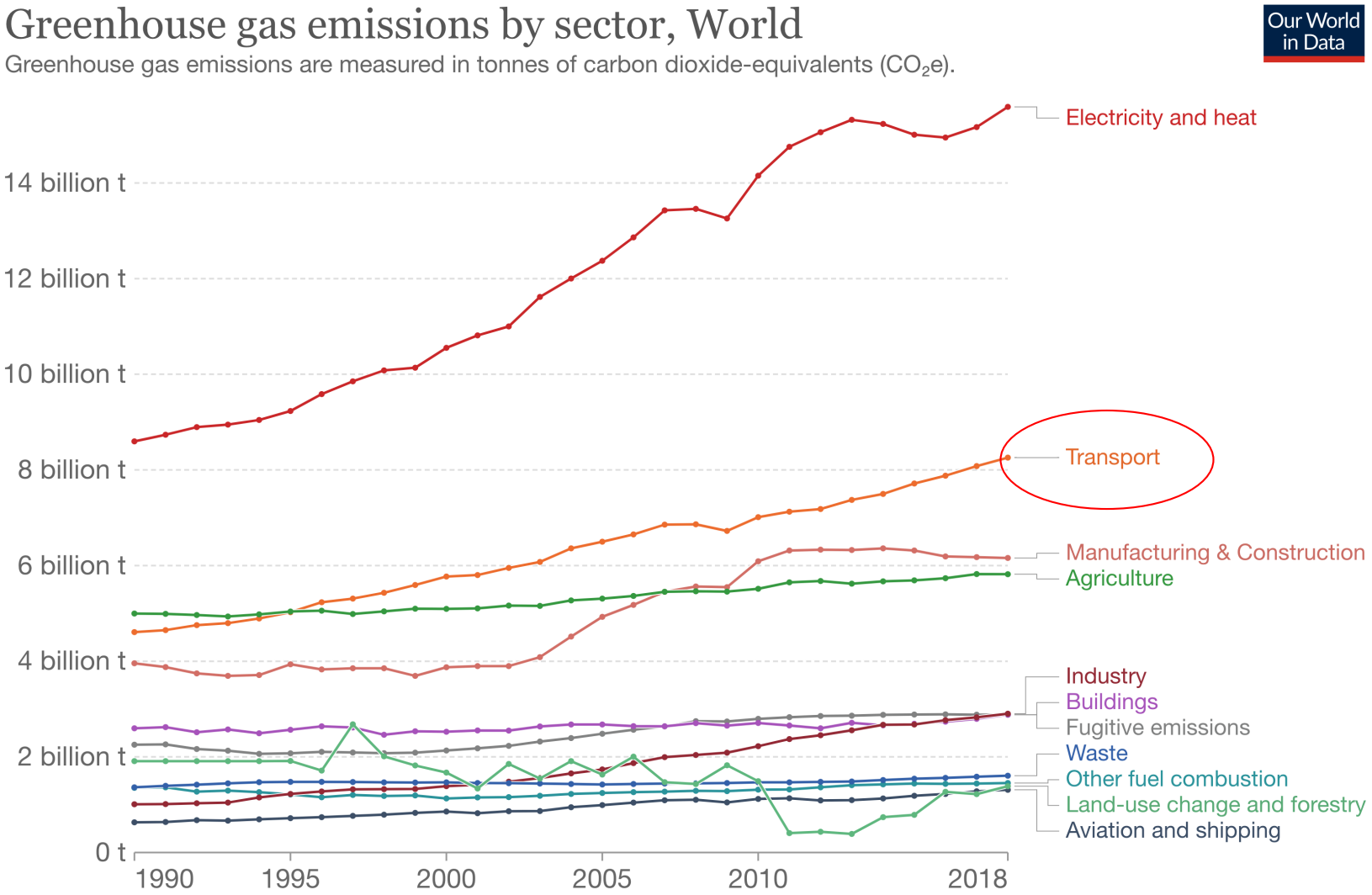
DEPARTMENT OF ECONOMICS

DAVIS ENERGY ECONOMICS PROGRAM

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Transportation is a major/growing source of GHGs (~20%)



Electrification vision

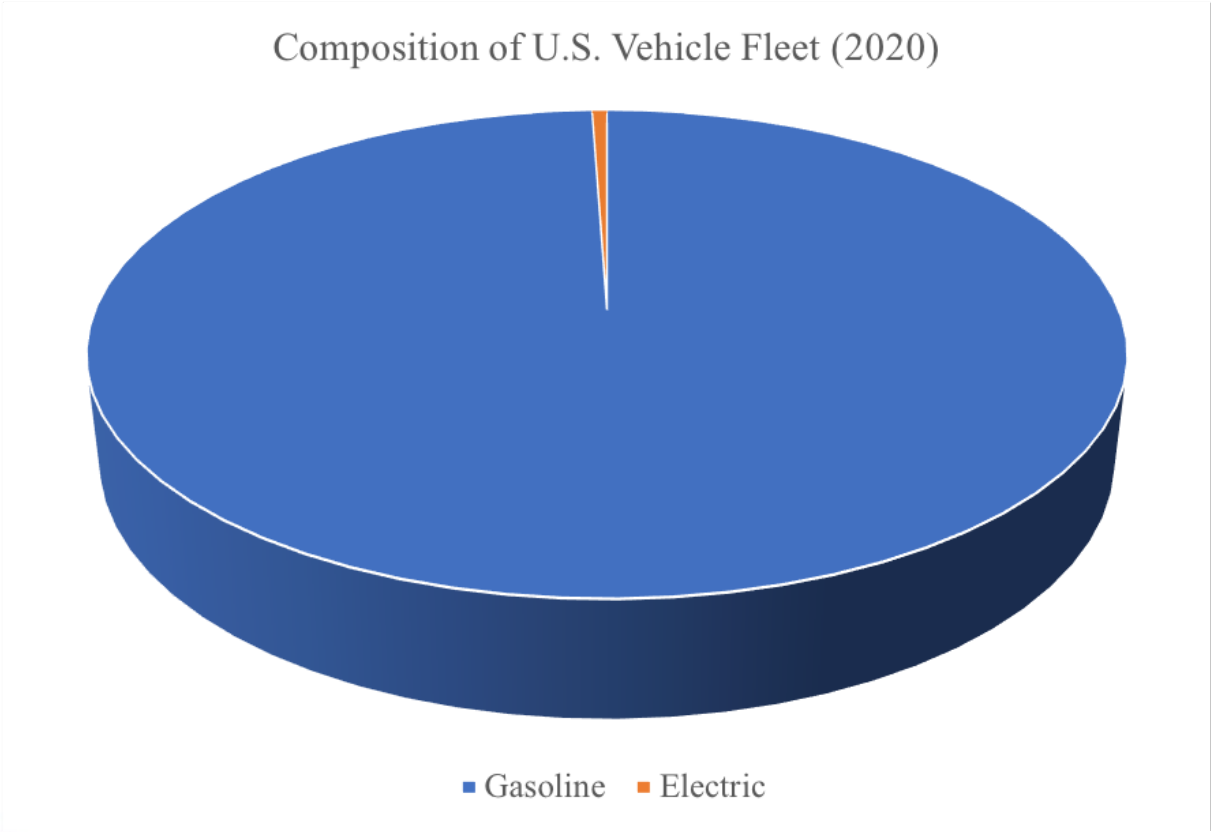




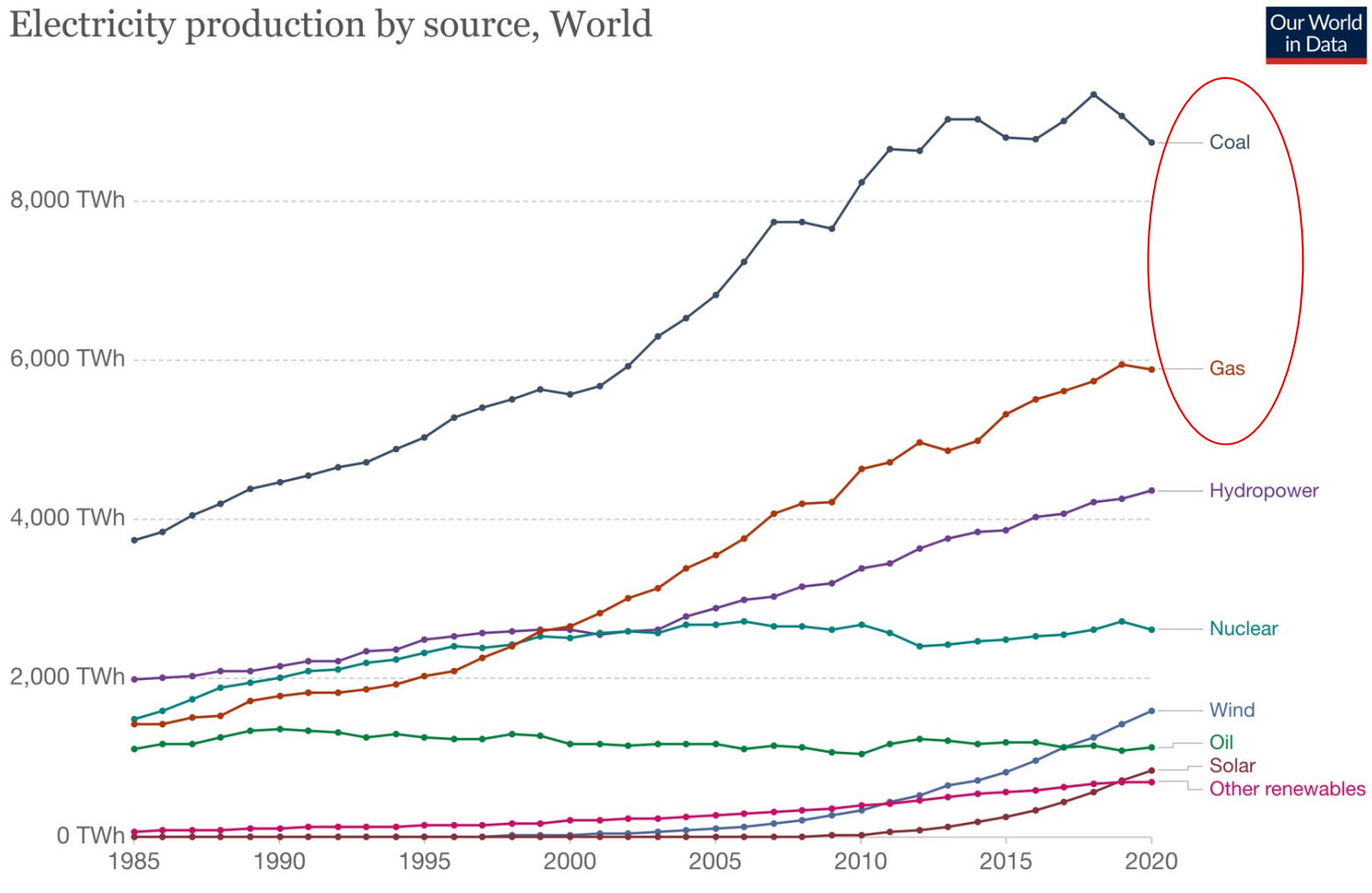




We drive mostly gasoline-powered cars (US & worldwide)



~60% of electricity comes from fossil fuels (high GHG)



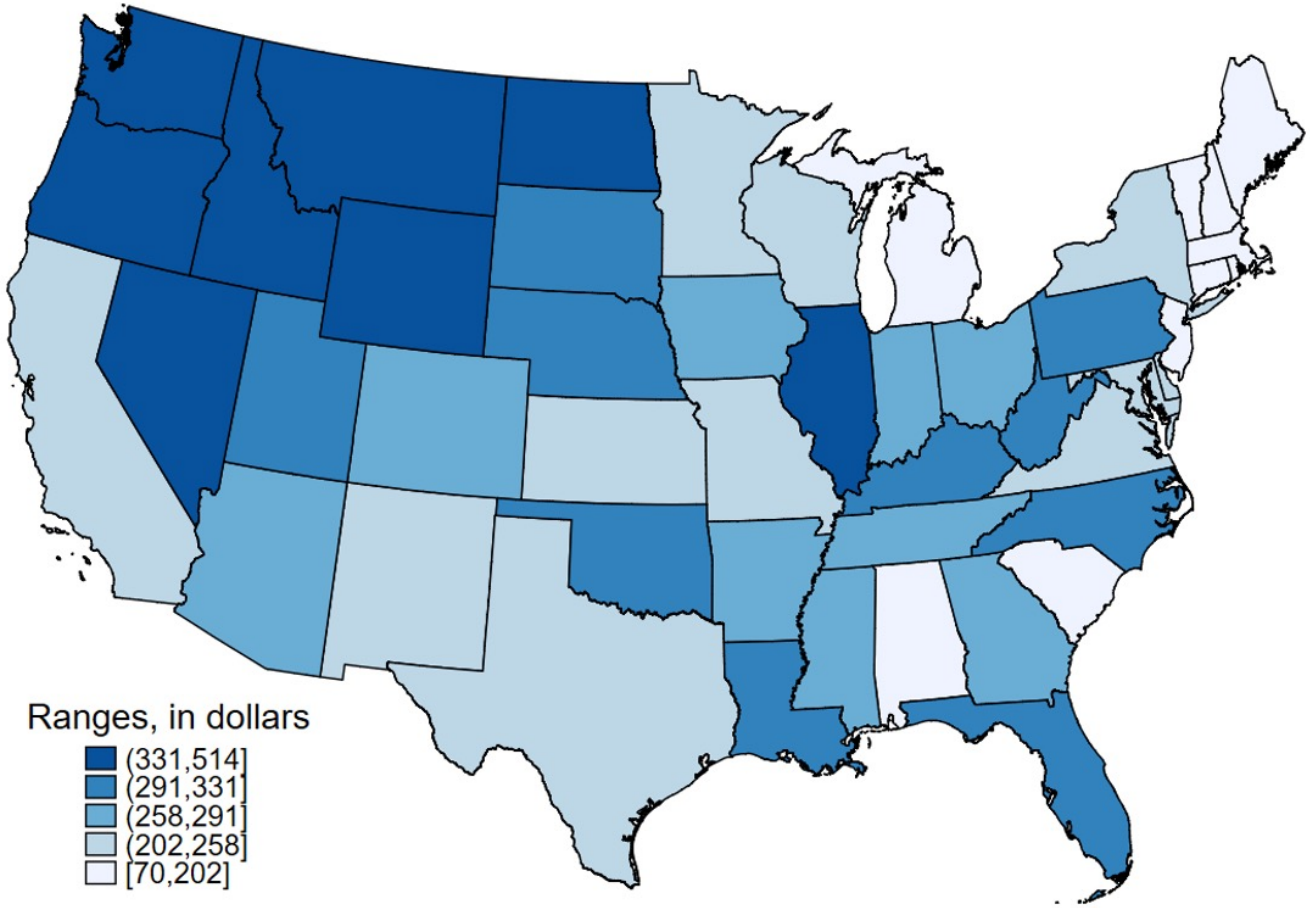
Today

- Private economics of EVs
- (Potential) externalities
  - Unpriced global & local pollution
  - Non-appropriable learning by doing
  - Network effects (charging infrastructure)
- Concluding remarks

Informs desired incentives and optimal policy

Private savings varies substantially by location

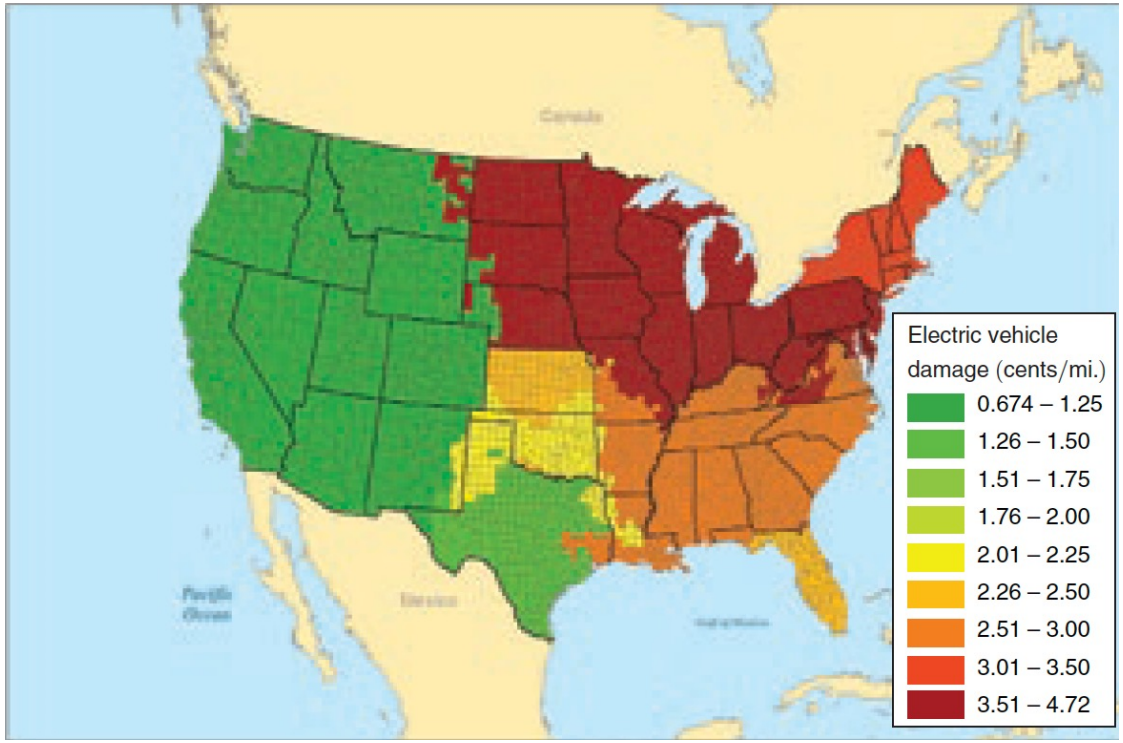
- 2019 Nissan Leaf vs Nissan Versa



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EVs are not "zero-emissions vehicles"

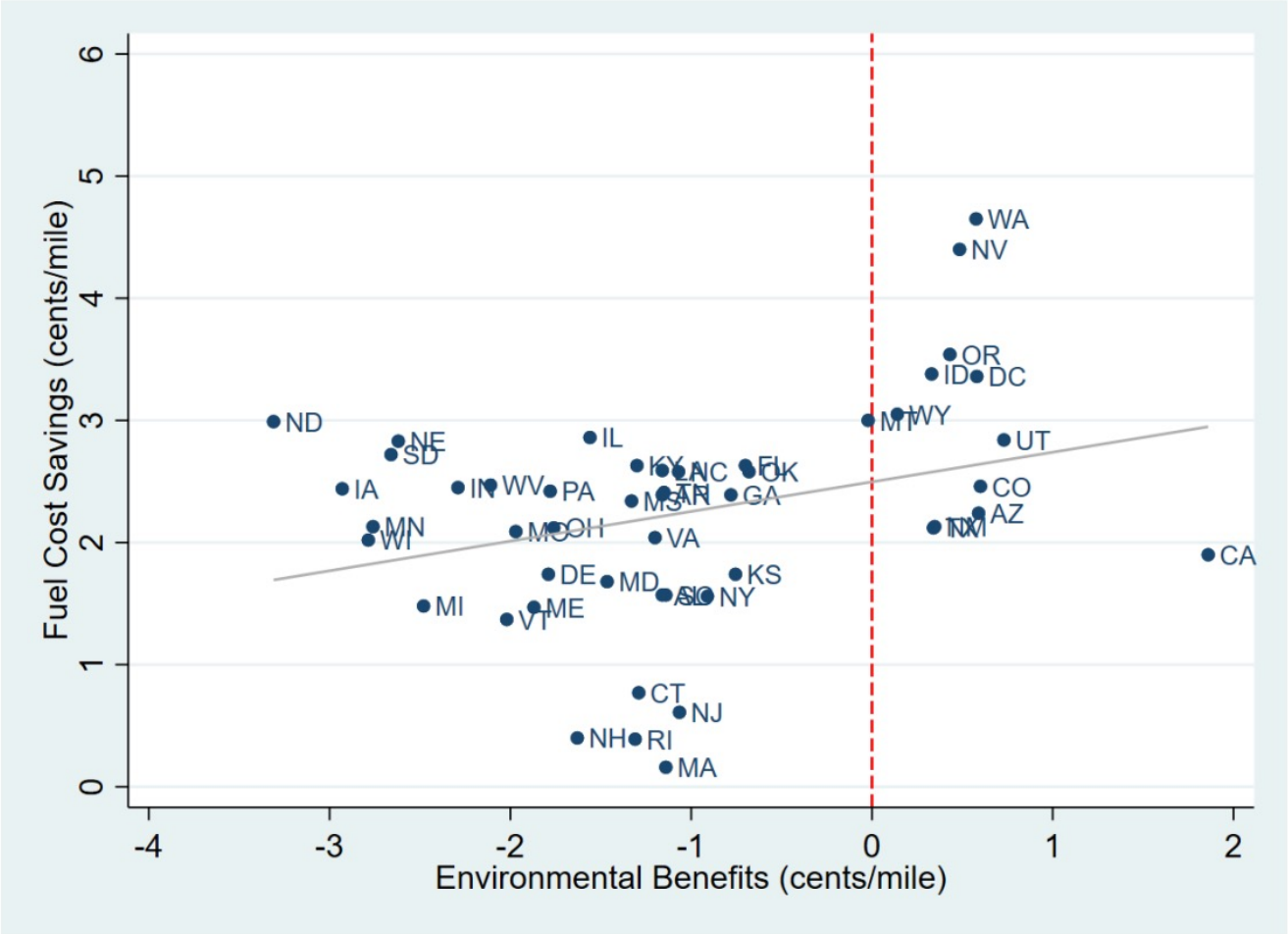
- 2021: Midwest grid 70% fossil fuel generation (30% coal)
- US coal production increased ~10% YoY in 2021Q4



Source: Holland, Mansur, Muller & Yates 2016

Cost savings positively correlated with environmental benefits

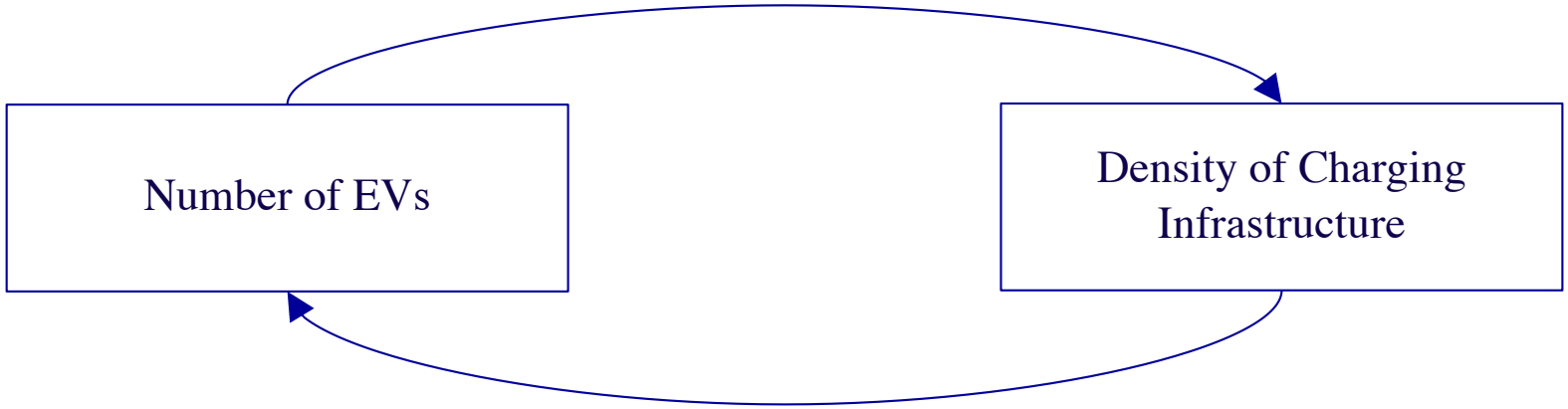
- But environmental benefits are negative in most states



Panel (a): Ford Focus Electric vs Ford Focus ICE

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Indirect Network Externalities



- If external (likely, to some extent), justifies either
  - Subsidize EV purchases
  - Subsidize EV charging infrastructure

Indirect Network Externalities

- Multiple equilibria?
  - Low EV / low charging infrastructure
  - High EV / high charging infrastructure
- Market failure exists if
  - Hurdle prohibits achieving “high” equilibrium *AND* if welfare in “high” equilibrium exceeds welfare in “low” equilibrium
- Little empirical evidence to inform relative welfare levels
  - “High” equilibrium: higher environmental benefits, also higher costs

EV Purchase Subsidies

There are many.

- $7,500 federal subsidy (up to $1.5B per manufacturer)
  - Proposals to renew/replenish
- Many state subsidies
  - E.g. CA: CVRP offers $1,000 - $7,000 per EV
  - Additional low-income subsidies up to $9,500 per EV
- Subsidies at this level far exceed environmental benefits (which, again, are negative in many cases)

Subsidizing EVs produces unintended consequences

- Puts more cars on the road
- Fails to reduce driving in gasoline cars
- Promotes driving EVs in areas with coal electricity
  - Driving EVs is typically cheaper per mile in those locations
- If successful, drives down the price of oil
  - Changes incentives in rest of world

EV Charging Infrastructure Subsidies

- Again, in the billions of dollars
- Potentially important for stimulating demand for EVs in MUDs
  - Is this desirable?

A few questions/concerns:

- If EV purchase subsidies are optimal (or excessive), can infrastructure subsidies be justified on network externality grounds?
  - Are there other market failures?
  - Standardization?
- Often directed towards government-determined locations
  - Would the market allocate these more efficiently?
- Sunk costs

Is it more cost-effective to subsidize infrastructure than EVs?

- Extremely challenging to identify empirically
- Best-in-class papers
  - Springel (2021): uses EV incentives as IV for charging station density
  - Li, Tong, Xing & Zhou (2017): use grocery stores and supermarkets as IV
- Exclusion assumptions are strong (and untestable)
- Recommendation: deploy infrastructure subsidies in a manner that allows credible ex-post evaluation

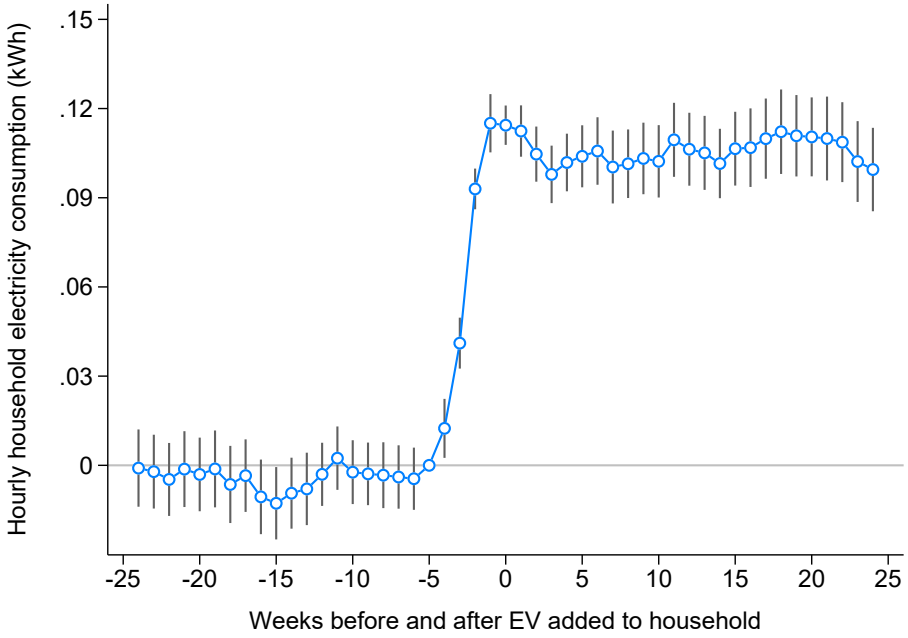
Learning by Doing

Key questions

- Does meaningful learning occur in EV (and related) markets?
- Is this learning appropriable by firms?

- Very little evidence in general; no evidence in EV market

Remarks (1): Are EVs and ICEs substitutes?



(+) Adjust for away-from-home charging

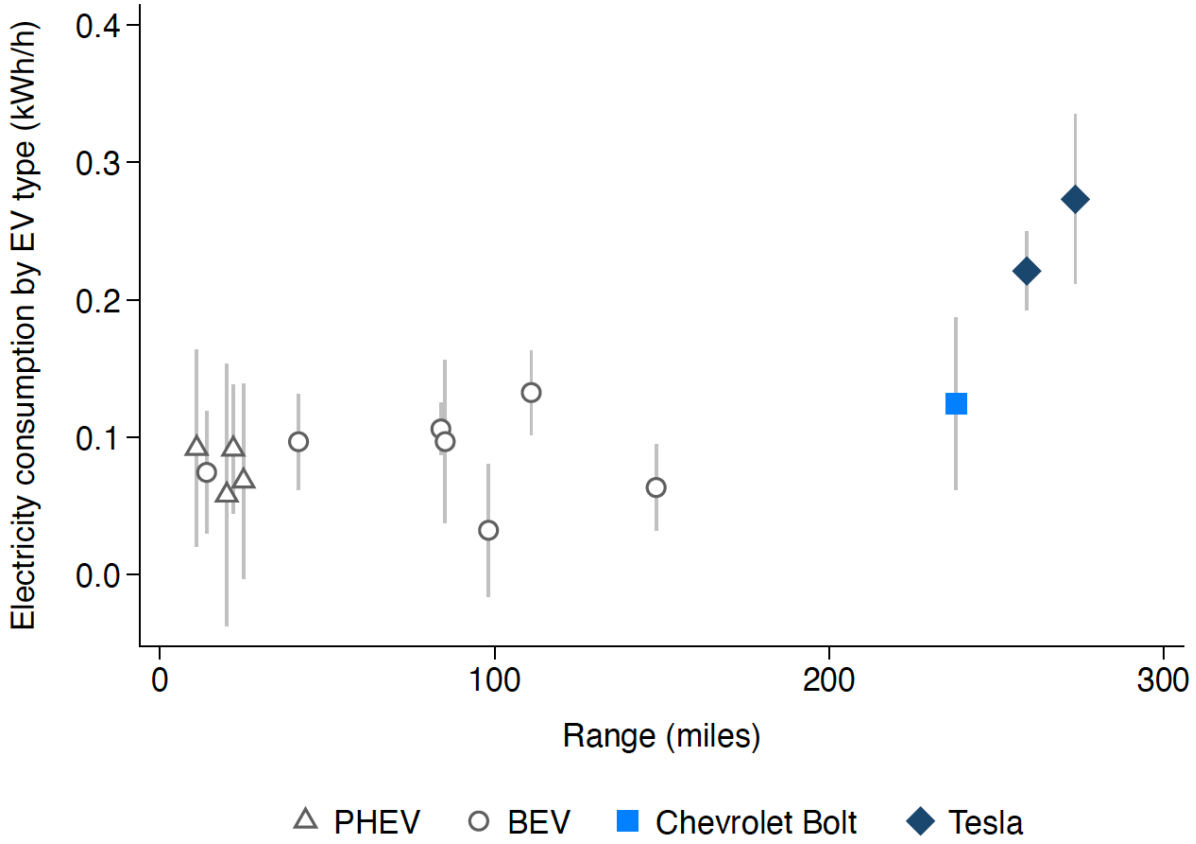
(+) Adjust for fuel efficiency

eVMT = 6,700 miles/BEV/yr
vs
10,000 miles/gas car/yr

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Source: Burlig, Bushnell, Rapson & Wolfram (2021)

Remarks (1a): Tesla vs range effects



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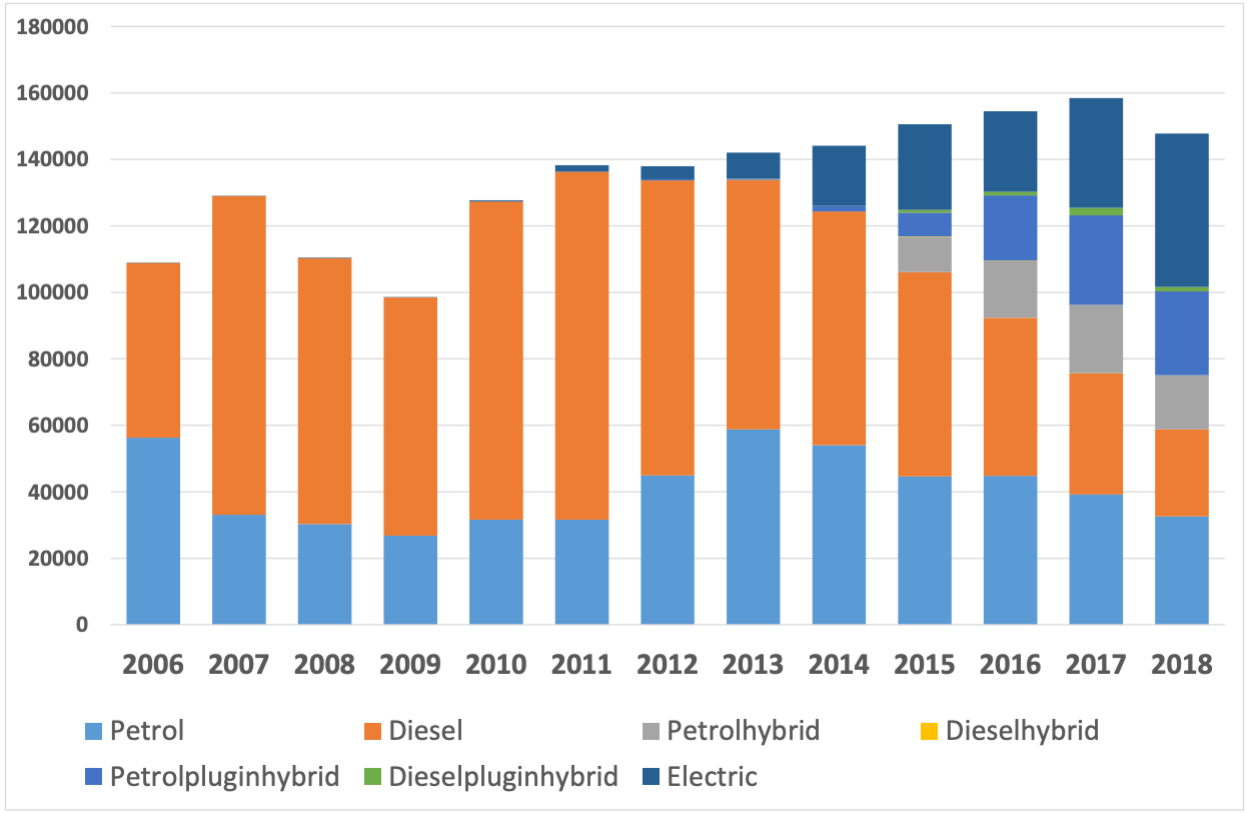
Source: Burlig, Bushnell, Rapson & Wolfram (2021)

Remarks (2): Norway

- 84.2% EV market share in April 2022

Figure 1.2. New passenger cars registered in Norway

2006-2018



Source: Data obtained for this report from Norwegian Road Federation.

- No EV subsidies (aside from HOV lane access, toll exemptions, etc)
- Massive taxes on gasoline cars ($72k/car in 2018[1])
- 98% renewable electricity (hydro → replicable?)

(1) Eskeland & Yan 2021

Concluding remarks

- Aspiration: complete transformation of the transportation economy
  - Replace $800 billion/year in liquid fuel expenditures with electricity (currently a $400 billion/year industry)
- Abatement benefits likely to be lower than expected, at least in the short run
- Optimal policies will vary over time and space
- There are several important, unanswered questions
- Benefits to remaining open-minded about alternative abatement pathways

Comments welcome:

David Rapson
dsrapson@ucdavis.edu

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