WAT-E2080 Water & Governance

Lecture topic: Externalities

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NOBEL PRIZE 2018 IN ECONOMICS

WILLIAM D. NORDHAUS

"for integrating climate change into long-run macroeconomic analysis"

PAUL M. ROMER

"for integrating technological innovations into long-run macroeconomic analysis"

Plan for the lecture

- Nordhaus has worked on negative externalities in climate change, the topic of this lecture. Romer has worked on positive externalities in innovation activity, to be covered later today
- Externalities motivate policies in economics: What is an externality?
- Policy questions: What should be policy design for externalities? What is the impact on businesses?
- Illustrations: (i) EU-ETS and (ii) transportation sector

Externality is a market failure

This figure illustrates a market failure

Beijing shrouded in smog.

Francesca Dominici et al. Science 2014;344:257-259

Published by AAAS

An illustration of measurement: pollution externalities

Chen et al. (2013, PNAS) consider a quasi-experimental empirical approach is based on China's Huai River policy, which provided free winter heating via the provision of coal for boilers in cities north of the Huai River but denied heat to the south. An arbitrary Chinese policy that greatly increases total suspended particulates (TSPs) air pollution is causing the 500 million residents of Northern China to lose more than 2.5 billion life years of life expectancy.

An illustration of measurement: China's Huai River policy

Figure: The cities shown are the locations of the Disease Surveillance Points. Cities north of the solid line were covered by the home heating policy.

Crossing the river: impact on pollution

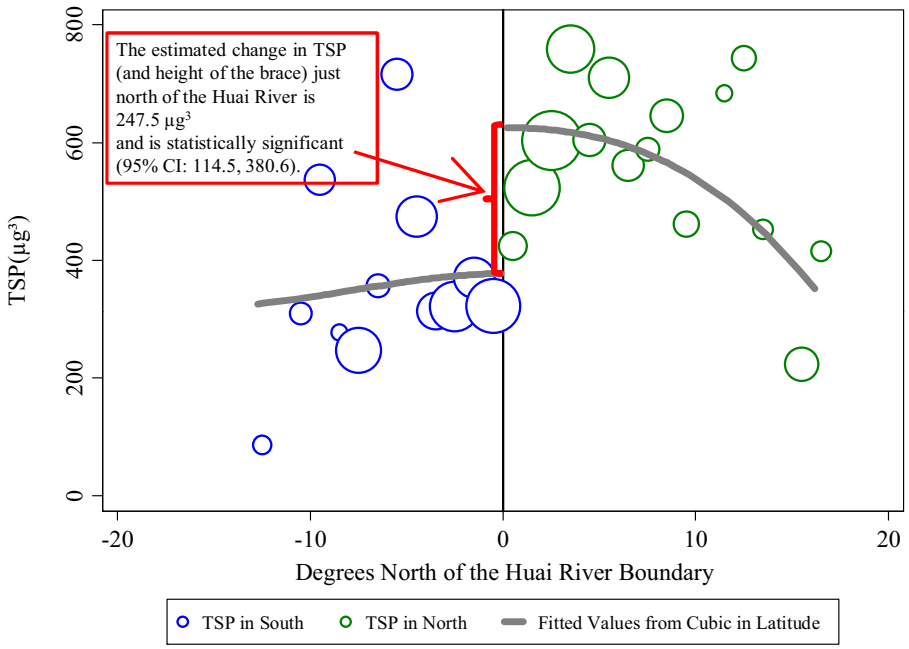


Fig. 2. Each observation (circle) is generated by averaging TSPs across the Disease Surveillance Point locations within a 1° latitude range, weighted by the population at each location. The size of the circle is in proportion to the total population at DSP locations within the 1° latitude range. The plotted line reports the fitted values from a regression of TSPs on a cubic polynomial in latitude using the sample of DSP locations, weighted by the population at each location.

Crossing the river: impact on mortality

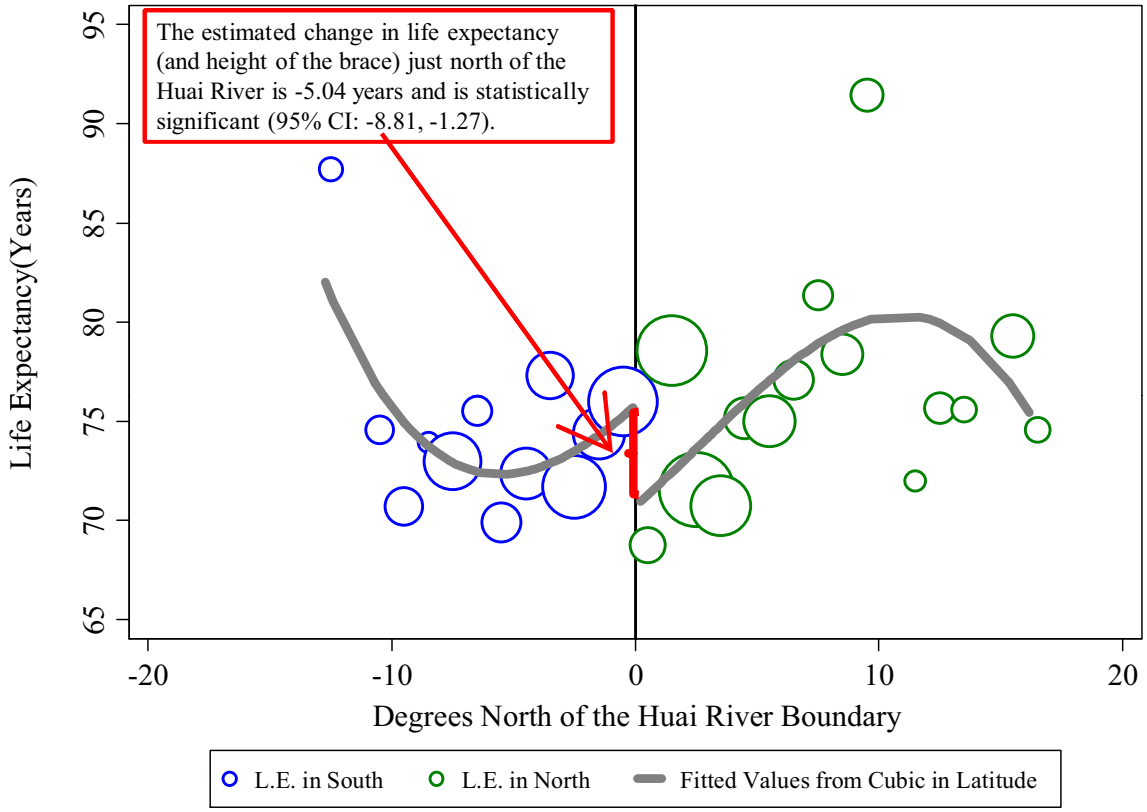


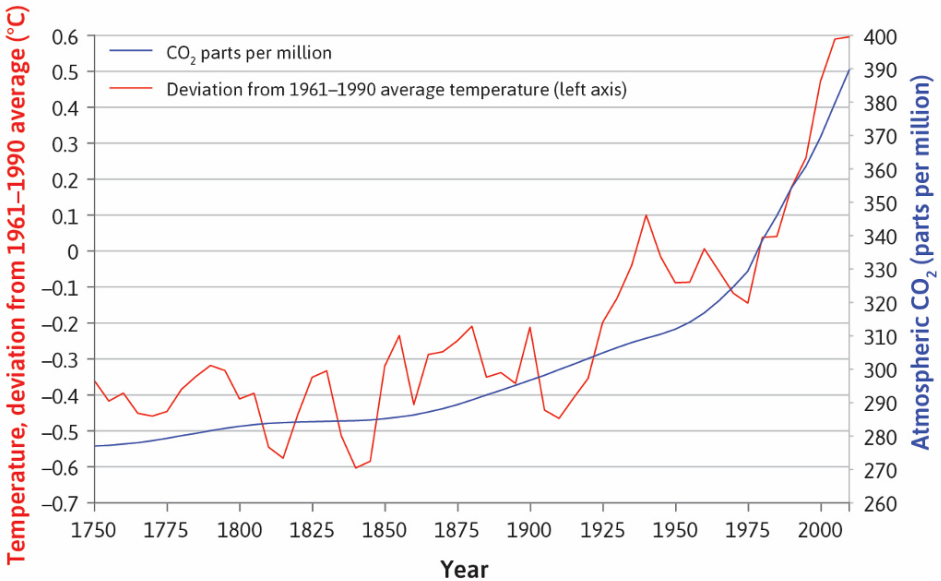
Fig. 3. The plotted line reports the fitted values from a regression of life expectancy on a cubic in latitude using the sample of DSP locations, weighted by the population at each location.

Climate change

Climate change

Climate change is a particularly difficult environmental problem to handle, for various reasons:

- Capping emissions is not enough (stock of CO2 matters, not the flow)
- May be irreversible → impacts may stay for centuries
- Requires global cooperation → game theory situation between countries
- Conflicts of interest (between/within countries and generations) → inequality and justice
- Worst-case scenario is catastrophic → Greenland ice sheet melting, etc.



How much carbon is in the ground?

Finiteness of fossil-fuel resources is not a market failure. But burning the fuels is a source of externalities

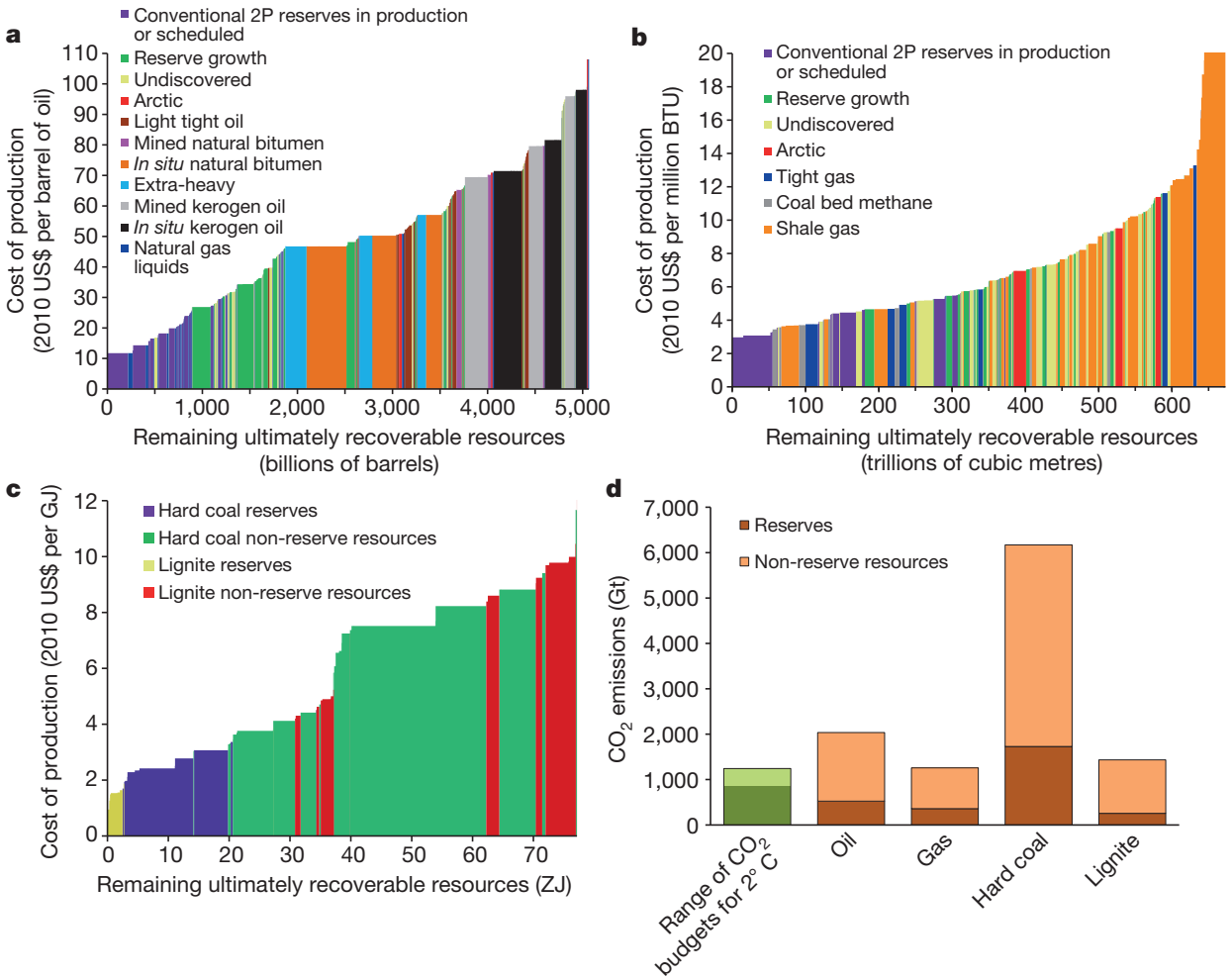


Figure 1 | Supply cost curves for oil, gas and coal and the combustion CO_2 emissions for these resources. **a–c**, Supply cost curves for oil (**a**), gas (**b**) and coal (**c**). **d**, The combustion CO_2 emissions for these resources. Within these resource estimates, 1,294 billion barrels of oil, 192 trillion cubic metres of gas, 728 Gt of hard coal, and 276 Gt of lignite are classified as reserves globally. These reserves would result in 2,900 Gt of CO_2 if combusted unabated. The range of carbon budgets between 2011 and 2050 that are approximately commensurate with limiting the temperature rise to 2 °C (870–1,240 Gt of CO_2) is also shown. 2P, 'proved plus probable' reserves; BTU, British thermal units (one BTU is equal to 1,055 J). One zettajoule (ZJ) is equal to one sextillion (10^{21}) joules. Annual global primary energy production is approximately 0.5 ZJ.

source: Glade & Ekins (Nature, 2017)

How to keep in the ground? Economists united:

The economic question: How can we achieve the desired carbon limit without excessive costs?

Policymaker's aim: Achieve the desired amount of effective abatement (e.g. units of CO2) at minimum cost.
There are 2 types of abatement policies:

1. **Price-based policies** use taxes and subsidies to affect prices. In the case of carbon budget, the aim is to use the tax to signal scarcity: the total available fossil resource for consumption is less than the amount in the ground
2. **Quantity-based policies** use bans, caps, and regulations

Cap and trade

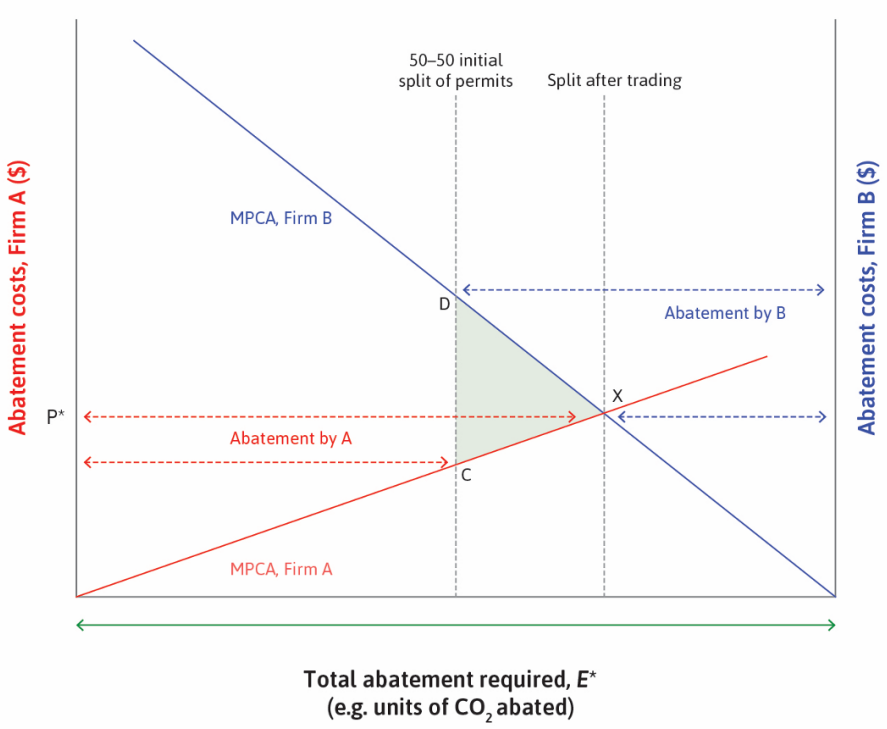
Environmental external effects arise because of missing markets.
Cap and trade creates a market for emissions:

- Government sets a limit (cap) on pollution and creates enough permits to meet this cap.
- Governments allocate permits (for example, via auction), and firms buy/sell permits amongst themselves.
- "Cap" sets the quantity and "trade" sets the price.

Cap and trade: Model

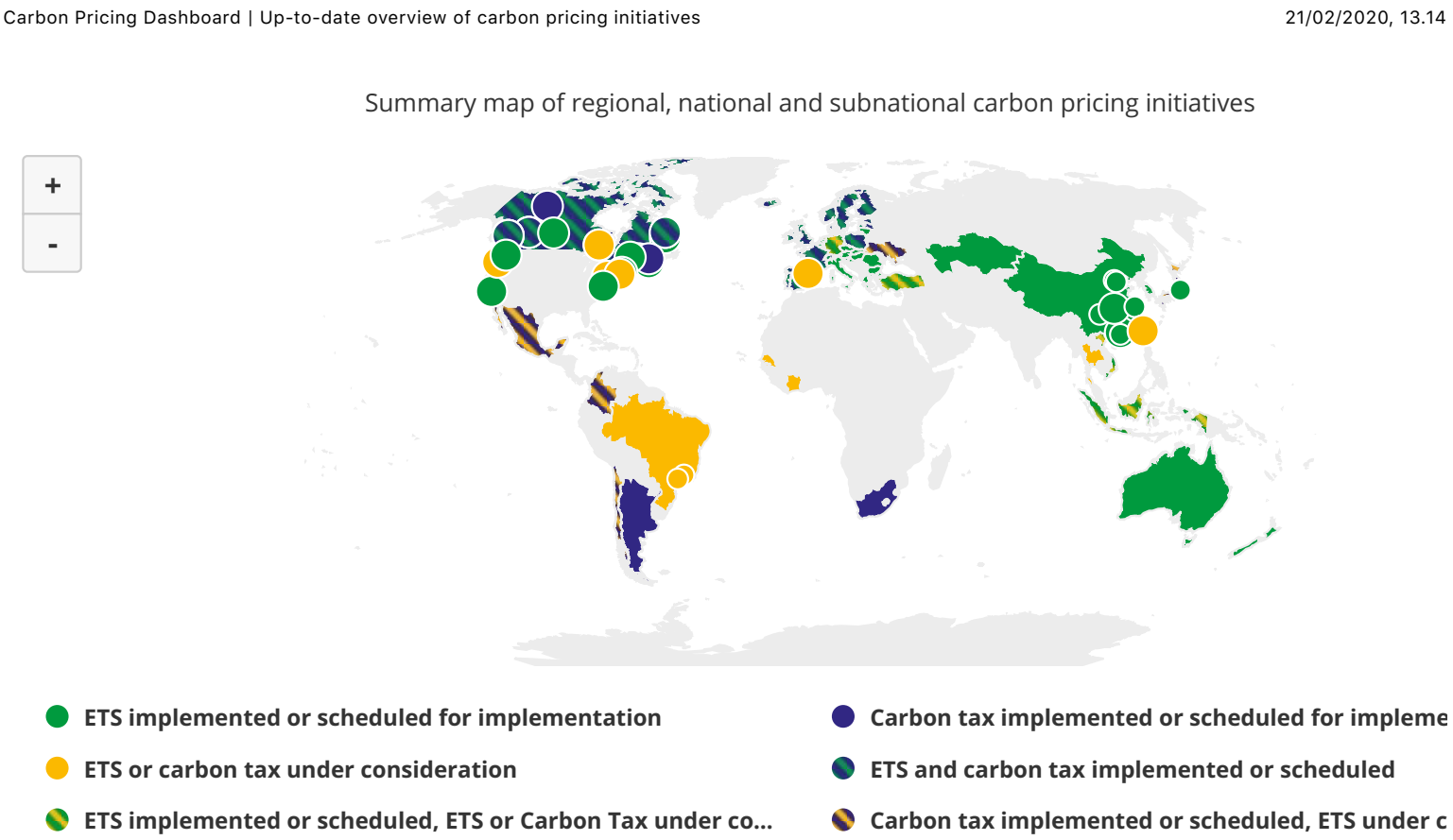
Firms trade until the permit price = marginal cost of abatement. Example: Firm A has a lower marginal private cost of abatement (MPCA) than Firm B. Firm A does more and benefits from trade with firm B.

- Both firms benefit from buying/selling permits until the MPCA is equalized across firms.
- Objective of cap and trade = abatement is done by the firms for which this is least costly.



Emission prices and cap-and-trade systems globally

(Link to the source) About 20% of global carbon emissions subject to some form of pricing



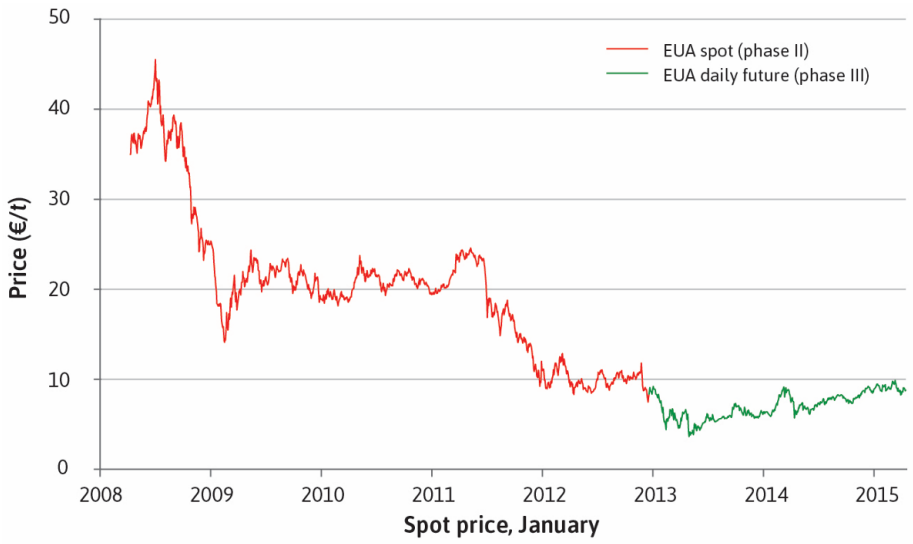
Cap-and-trade systems and taxes: differences

Cap-and-trade: prices can be volatile

- EU Emissions Trading Scheme set too large a cap. The price fell dramatically after the 2008 crisis, providing little incentive to abate.
- A price floor on permits can mitigate this issue (e.g. UK)

Tax: difficult to predict abatement

- For example, in Finland we have a carbon tax on gasoline but emissions do not decline



Big pressing policy question: How to transform the transportation sector?

The government has ambitious targets, *(Link to the source)*

Transport emissions to zero by 2045

PRESS RELEASE 12.12.2018 15.39 fi sv en

Picture: Ministry of Transport and Communications

Three steps for the government

1. How much to reduce emissions?
   - This is coming from the EU: 50% reduction
2. How to reduce emissions?
   - This is instrument choice question: prices or quantities or both
3. How to deal with distribution?
   - Distribution of income and efficiency can be separated: transfers to the poor to avoid "yellow vests".

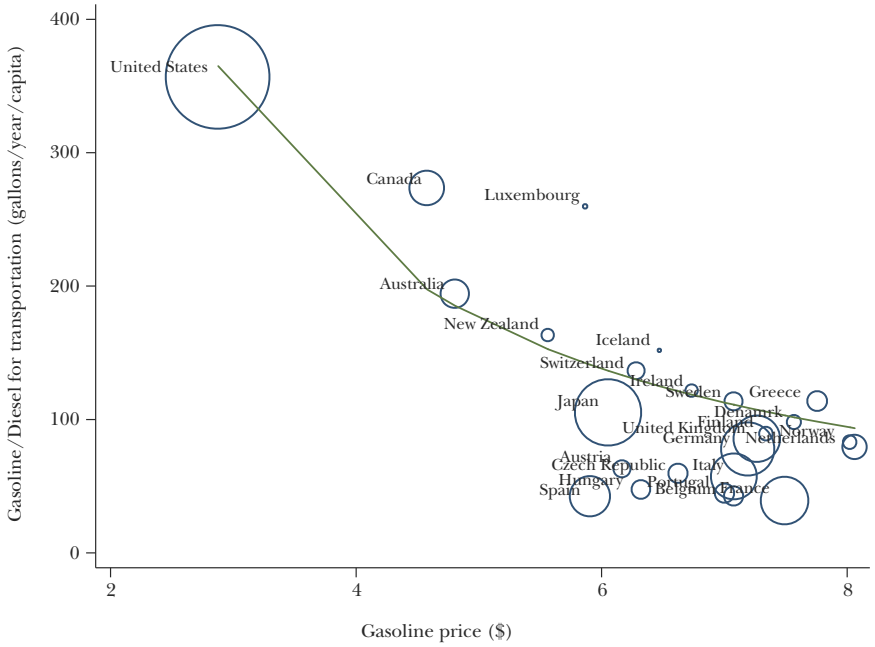
Currently in Finland we have a carbon tax but it is not helping to reduce emissions $\rightarrow$ tax should be higher. Next Figure shows that higher fuel prices have an impact on consumption if we compare countries

Price instruments: fuel taxes

Higher taxes → better fuel-economy

Figure 1

Transportation Fuel Consumption per Capita versus Fuel Price

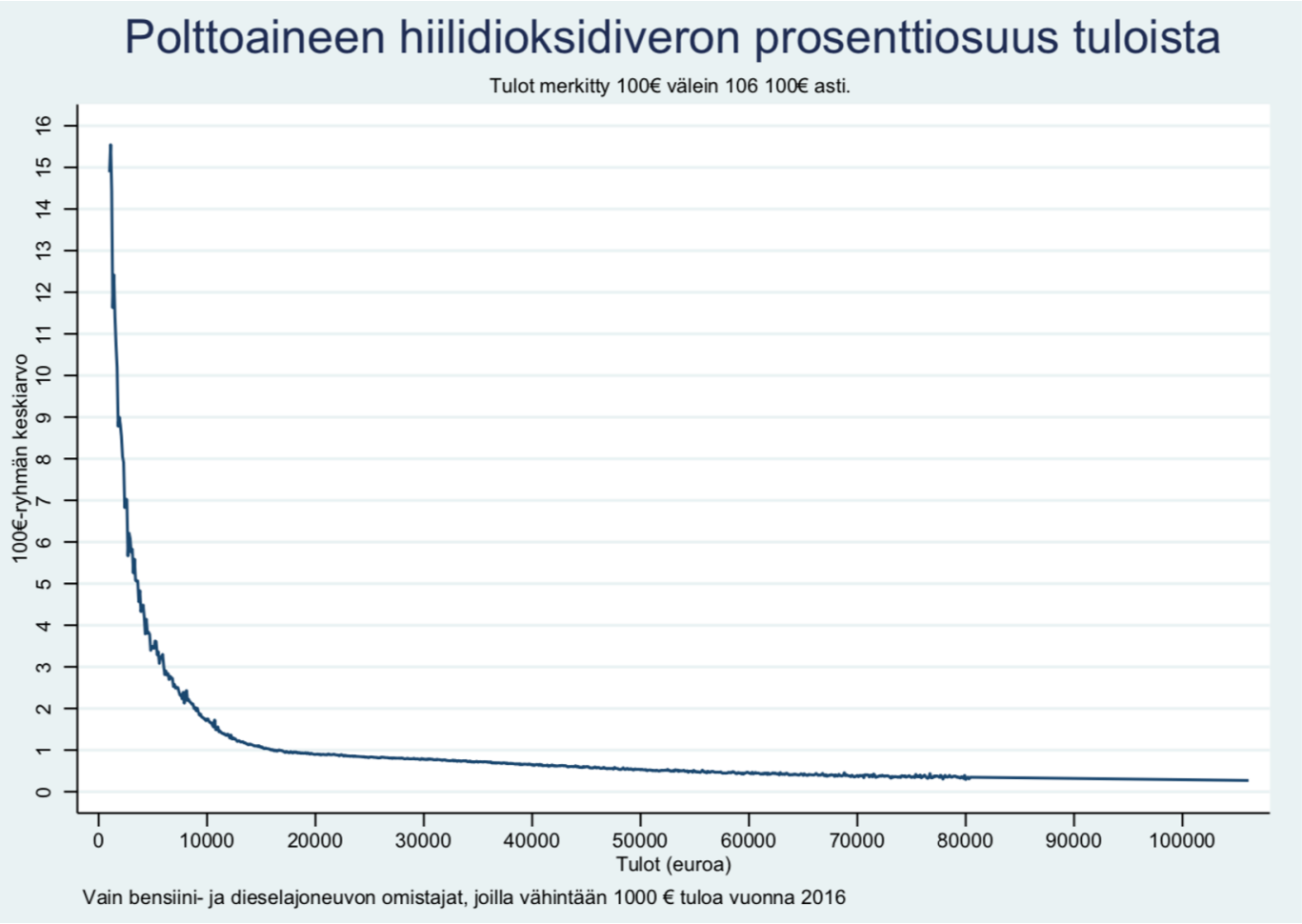


Source: Data from Worldbank.org.
Notes: Size of the circle proportional to population. The line is the fitted value from a regression of the log of consumption on the log of price.

Knittel, Christopher R. 2012. "Reducing Petroleum Consumption from Transportation." Journal of Economic Perspectives, 26 (1): 93-118.

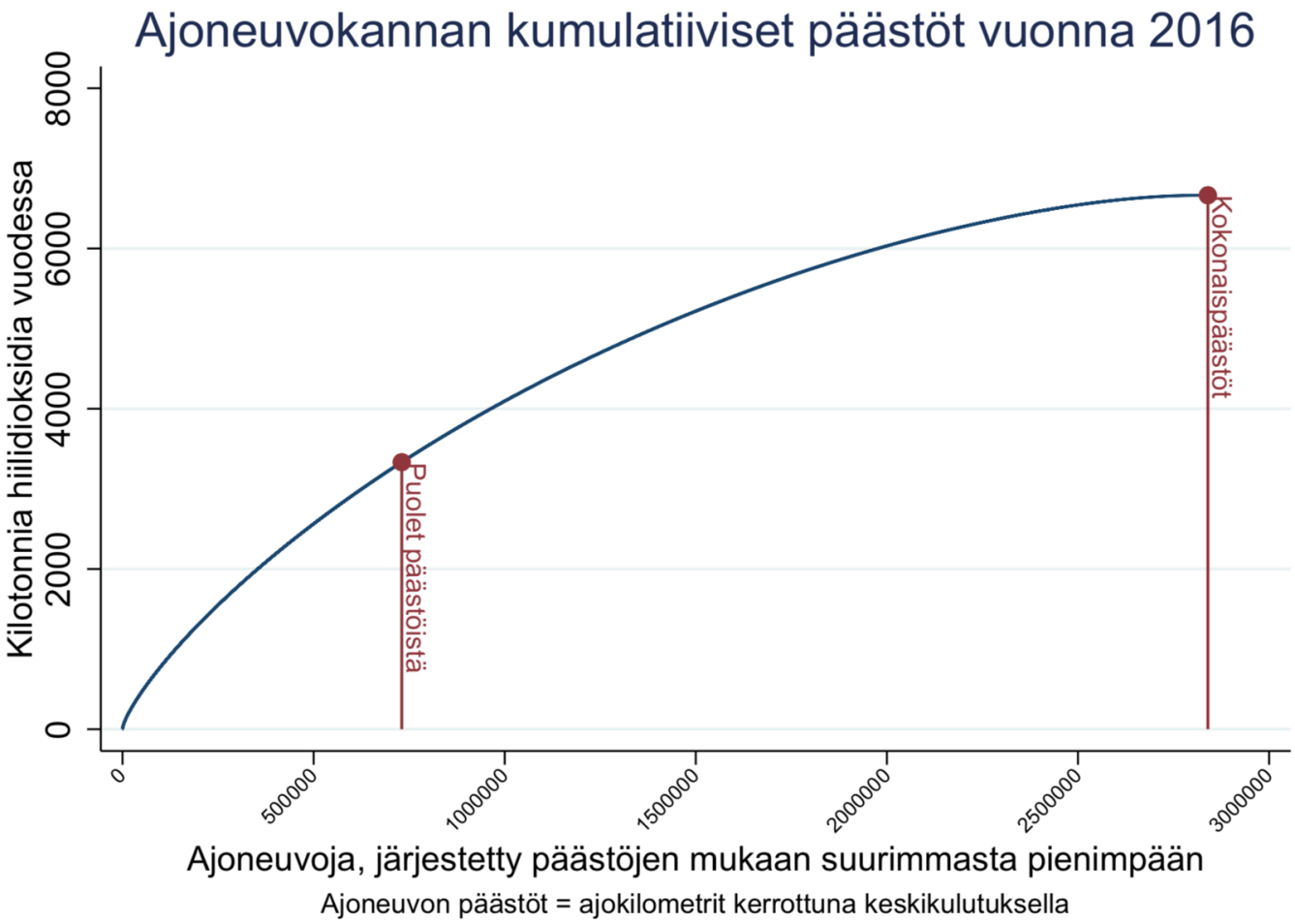
CO2 tax in Finland: ca. 17 cents/liter, in total 4.7 billion euros

- Figure shows all car owners, ranked in the order of their earnings
- It shows % of income spent on CO2 tax



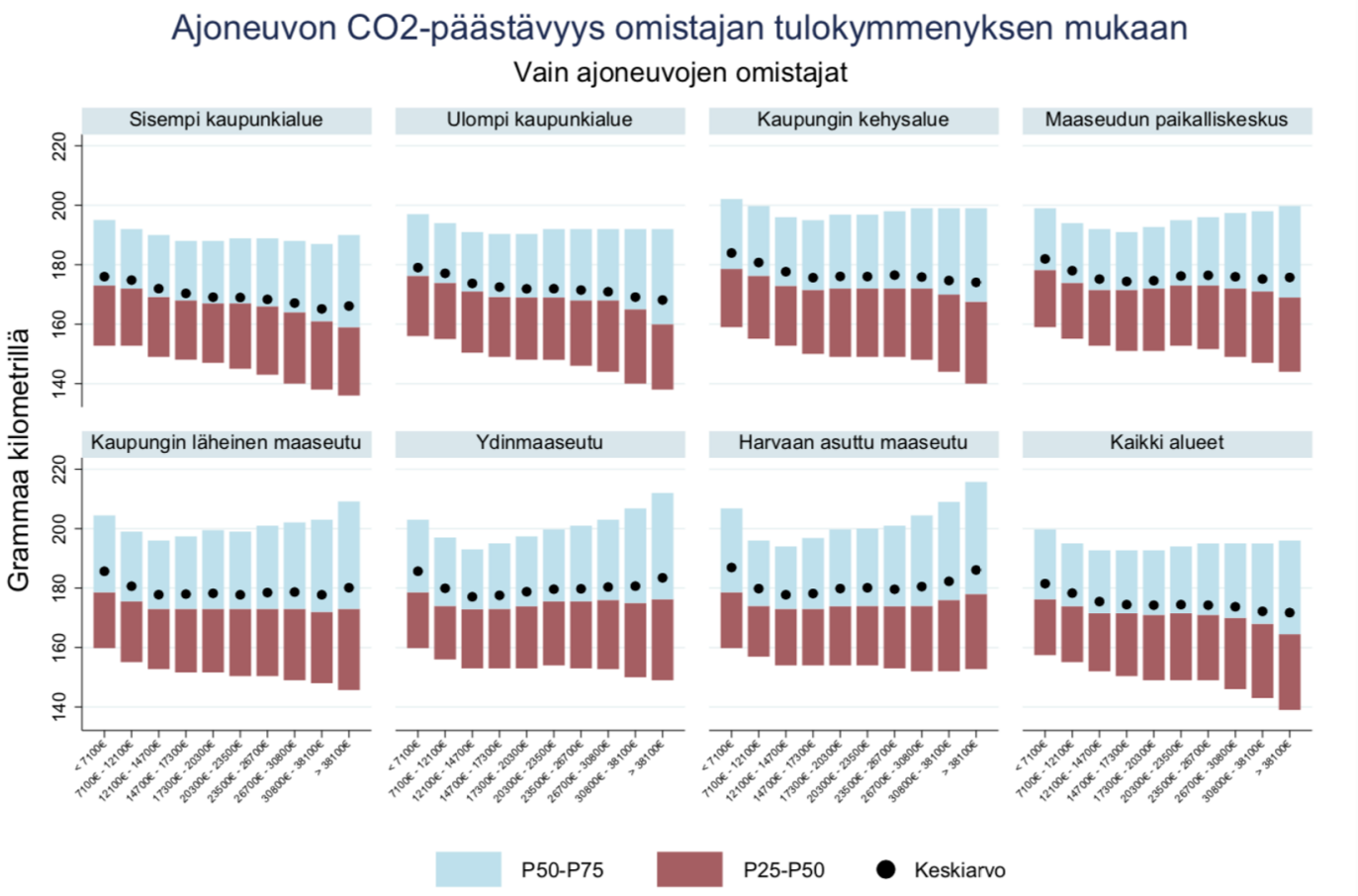
Who is producing the CO2?

- Figure shows all cars in circulation: 700 000 cars produce 50% of all emissions



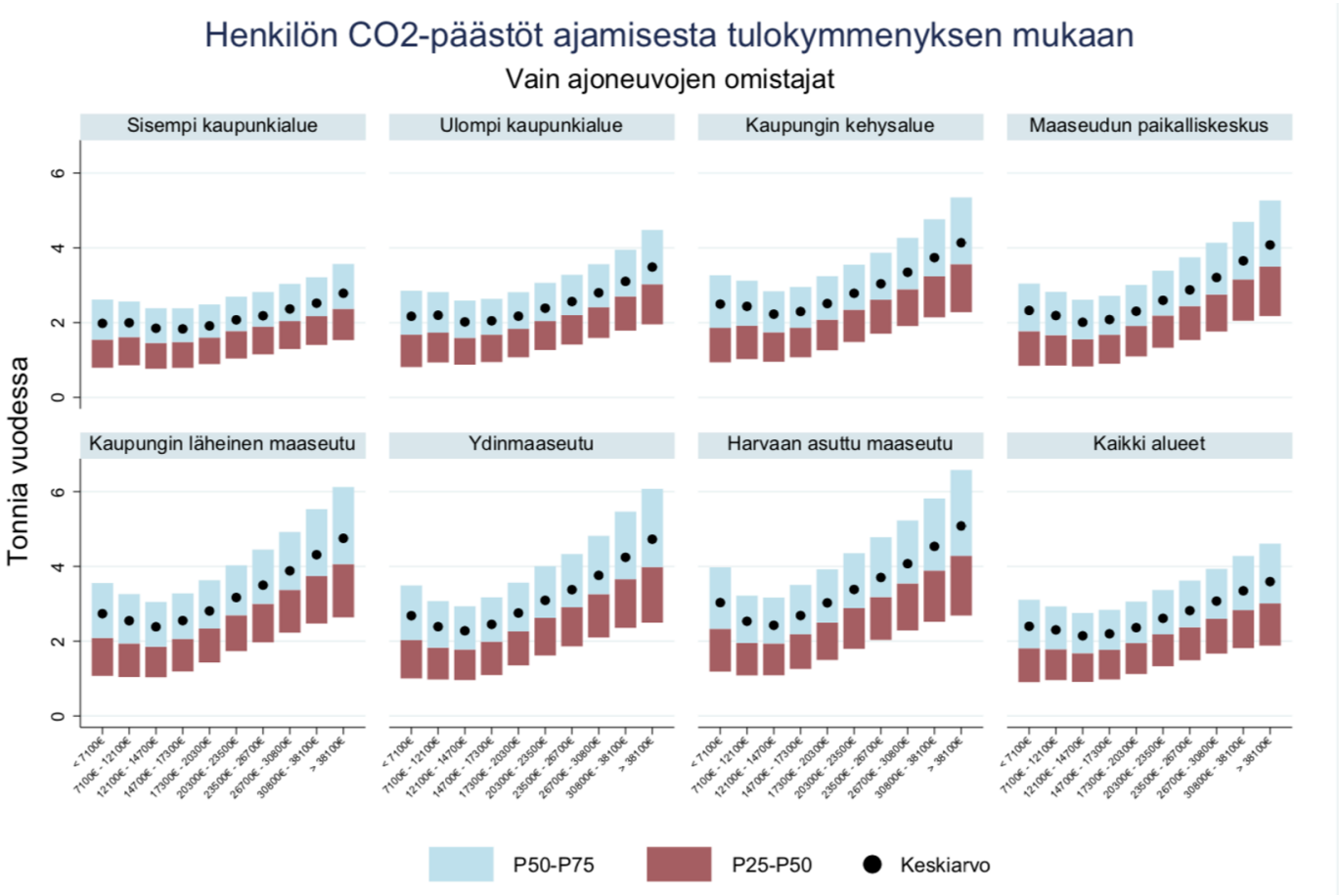
Who has the clunkers?

- Figure shows income groups and CO2/car in different parts of the country: poor drivers have dirtier vehicles.



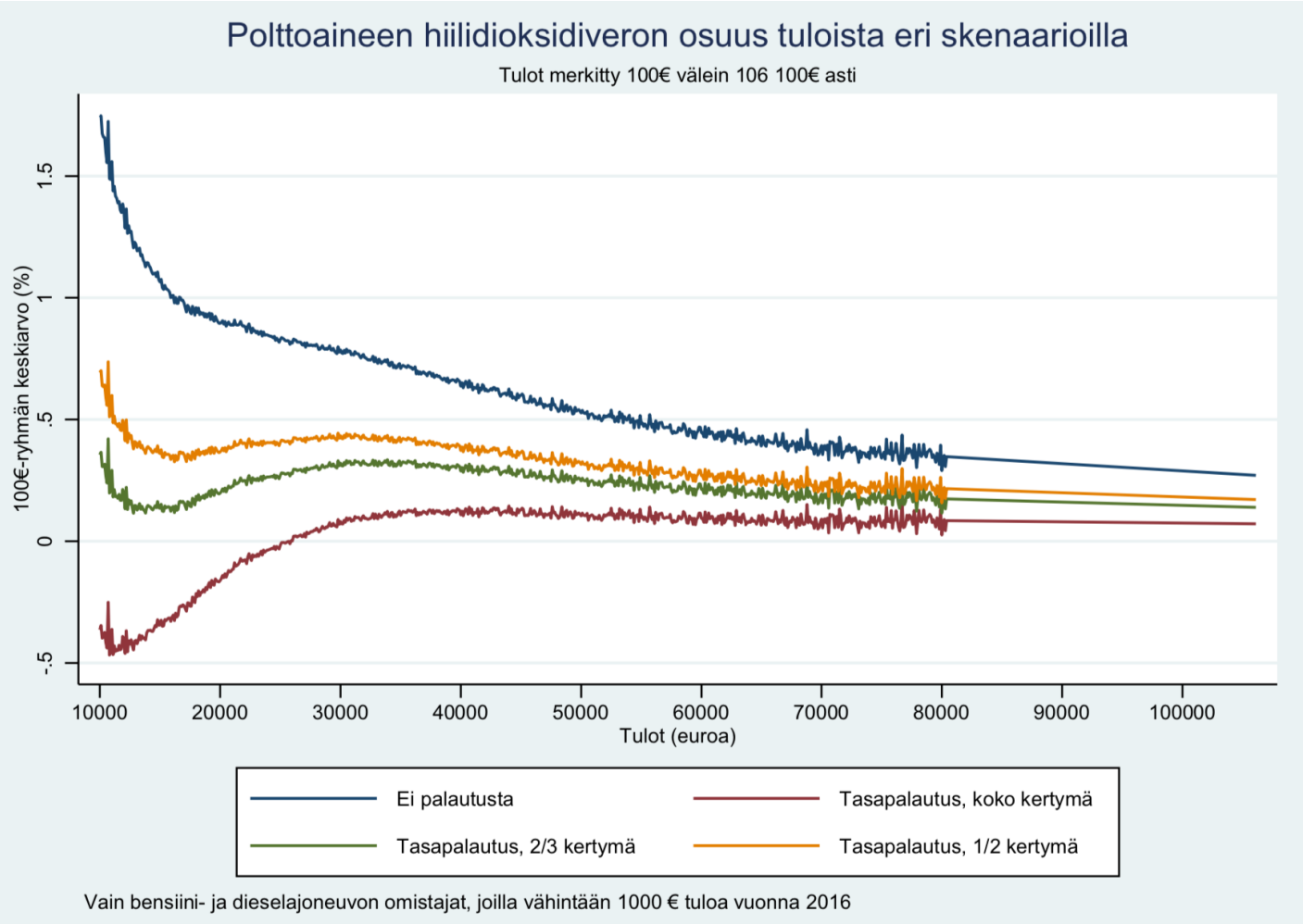
Wealthier drive more

- Figure shows income groups and CO2 emission from driving in total in different parts of the country.

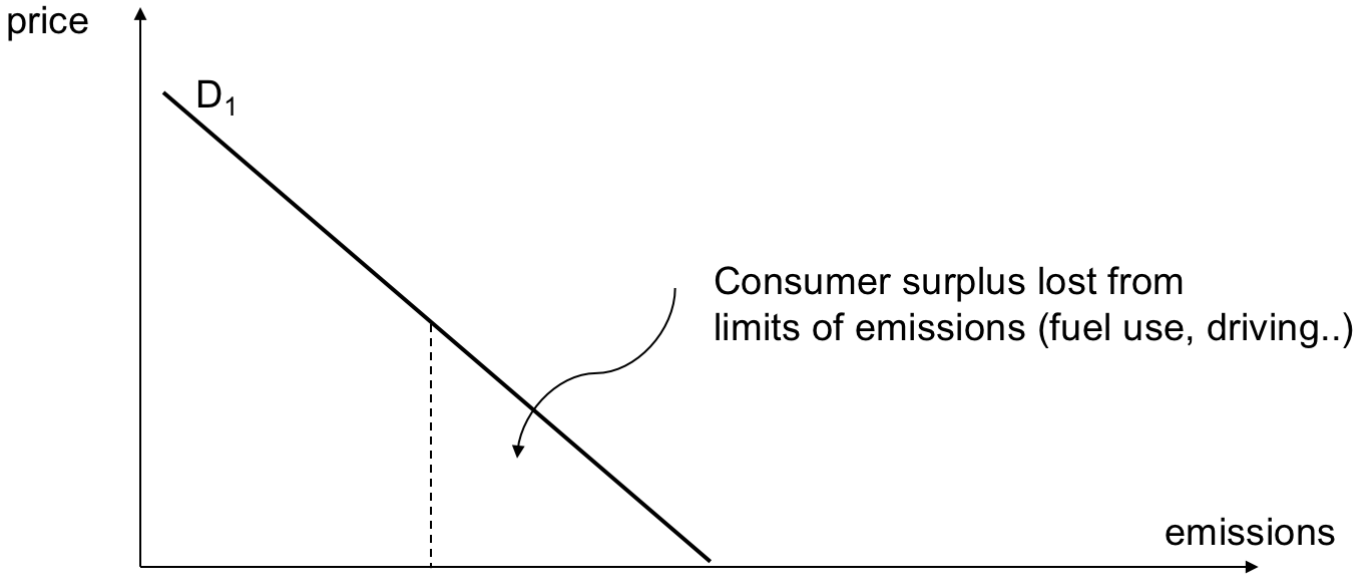


What would have happen if we gave the collected tax back to drivers as lump sum?

- Figure shows all car owners, ranked in the order of their earnings
- It shows % of income spent on taxes after receiving tax rebates, under different rebate rules.

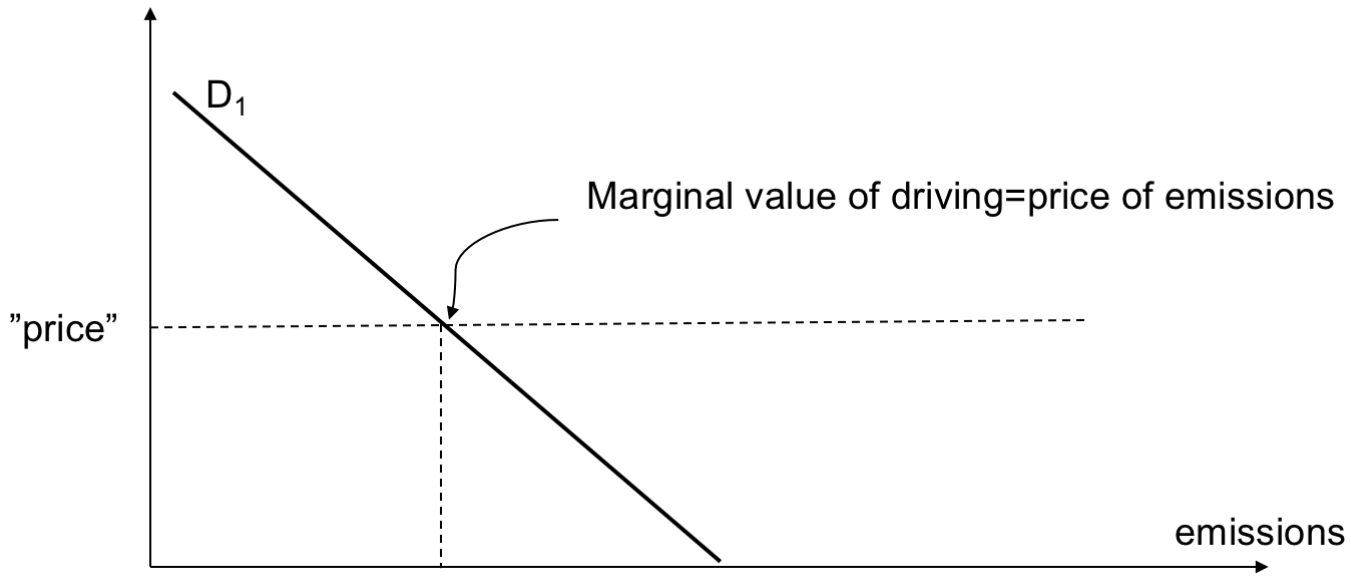


Summary: It is costly to impose restrictions on driving



Just like with firms, consumers have costs

Price incentives minimize the costs, and it is possible to deal with redistribution



Just like firms, consumers should respond to price incentives