Lecture 2.b: Instrument choice for climate policies: equity

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Where we stand

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  - Objective: attain a given climate target at the least cost.

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  - Objective: attain a given climate target at the least cost.

- Today's lecture: take into account how the aggregate cost is distributed across individuals.
  - From previous lecture: there exists different efficient allocations;
  - some are more/less favorable to poor individuals;
  - some lead to higher levels of social welfare.

$\rightarrow$ We won't assume any specific Social welfare function to determine the *optimal* policy, but rather describe the distributional effects associated with alternative policies.

Today's road map

1. Distributional effects in theory

2. Distributional effects within countries
   - Distributional effects of carbon taxes
   - Distributional effects of other instruments

3. Distributional effects across countries
   - Heterogeneous effect of climate policies
   - Heterogeneous effect of climate change

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Second welfare theorem

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Recall from previous lecture the First welfare theorem: in a competitive economy characterized by a certain number of assumptions (no market failure), *any equilibrium allocation is Pareto efficient.*

Second welfare theorem (not a formal statement): under another set of assumptions, *any Pareto-efficient allocation can be decentralized as a competitive equilibrium.*

Main takeaway: to address climate change, policy makers should:

- find policies that can fix market failures at the least possible cost, so that the equilibrium allocation is Pareto efficient;
- redistribute resources between individuals to choose the (efficient) competitive equilibrium that yields the highest social welfare.

Distributional effects in a simple economy

When the climate externality is the only market failure:

- efficiency and equity are addressed separately;
- the distributional effects from climate policies are irrelevant to the policymakers' choice as they can be addressed in a second stage;
- efficiency is about increasing the size of the pie, equity about cutting sufficiently equal shares;
- the bigger the pie, the more we can give to everyone.

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Example: if households are disproportionately impacted by a carbon tax on gasoline, should we reduce that tax?

- No, fix the tax to correct the externality, and adjust income taxes and transfers to address distributional concerns.

Does it mean distributional effects are irrelevant in climate policy analysis? $\rightarrow$ No, critical to assess them to correctly design the transfer scheme!

Distributional effects in the real-world

- In a simple economy: no matter the initial allocation, transfers can be designed to attain another (preferred) efficient allocation.
- However: sometimes, these transfers are not feasible.
- Example: when taxing gasoline, all households experience different forms and levels of costs:
  - in theory, the government could design targeted transfers depending on these costs;
  - in practice, this would require too much information $\rightarrow$ personalized transfers largely unfeasible.
- In this case, we cannot apply the Second welfare theorem: equity and efficiency cannot be treated separately anymore!

$\rightarrow$ The choice of the climate policy instrument now depends on its distributional properties!

Market-based *vs.* Command-and-control mechanisms

- No general result about how market-based mechanisms perform relative to command and control instruments from a distributional point of view.

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- In general, pollution regulation affects more those who pollute more:
  - if agent A emits more CO_2 than agent B, restricting the use of CO_2 or taxing it will impact agent A more than B;
  - if one form of regulation is regressive, an alternative form targeting the same pollution will likely be regressive as well.

- One specific feature of pollution taxes: they raise public funds:
  - the tax revenue can then be redistributed to address distributional effects;
  - obviously, the revenue can also be used for other purposes: limited resource with competing uses, as always.

$\rightarrow$ The revenue collection confers a big advantage to taxes over other policies to address distributional effects. Still, distributional effects of the tax cannot always be undone (cf. horizontal heterogeneity below), hence sometimes other policies may be preferred.

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Carbon tax's regressivity

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- Generally speaking, a progressive policy is one which favors individuals who were initially worse off relative to those who were initially better off. A regressive policy is the opposite.

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- Generally speaking, a progressive policy is one which favors individuals who were initially worse off relative to those who were initially better off. A regressive policy is the opposite.
- In particular, a carbon tax is generally said regressive if the share of their income people spend on this tax is decreasing with income.
- In developed countries: energy consumption typically represents a higher share of poor households' budget $\rightarrow$ carbon taxation is generally regressive.
- In developing countries: more ambiguous pattern, as poor households have significantly lower energy consumption (*e.g.* car ownership concentrated at the top of income distribution).

Example: the carbon tax is regressive in France

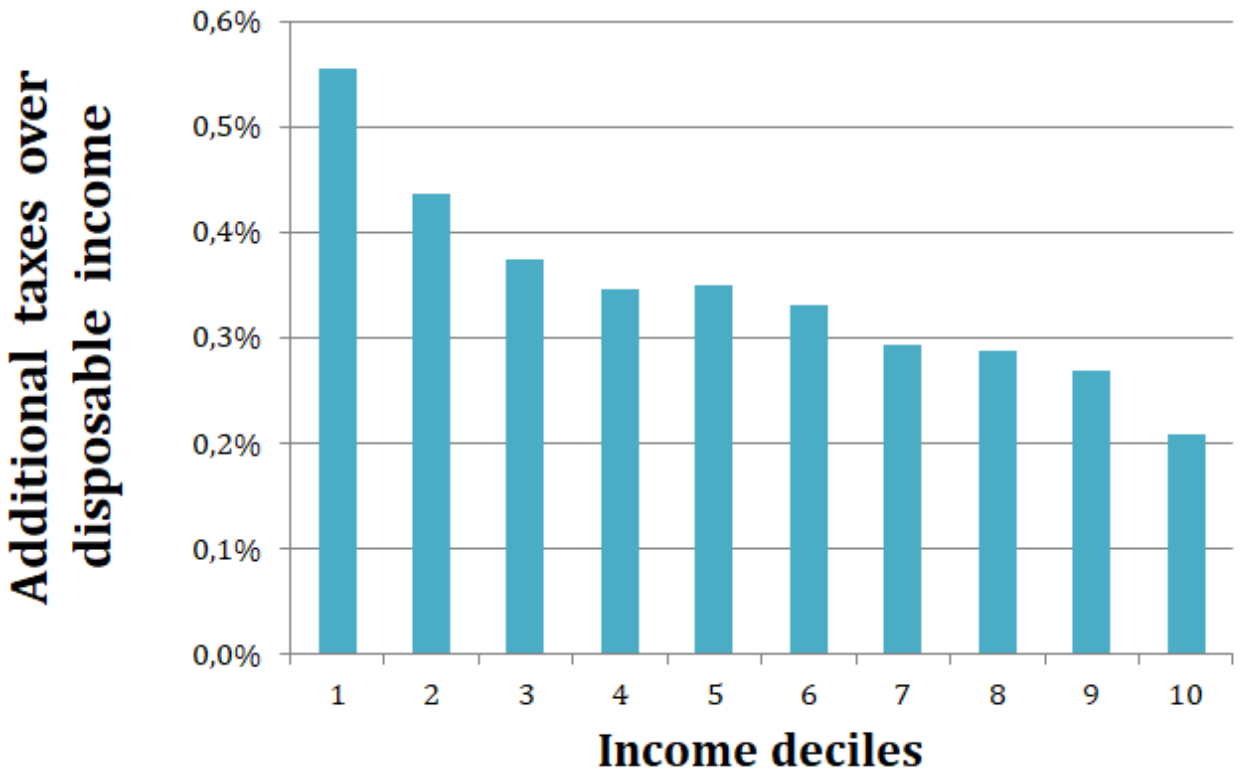

Figure: Average effort rate on the French energy policy reform 2016-2018 before revenue-recycling (from Douenne, 2020)

$\rightarrow$ Bottom 10% of the income distribution (1st decile) spend about 3 times more than top 10% (10th decile) as a share of their disposable income.

A solution to regressivity: carbon tax and dividend

- Poor households spend a larger share of their income in carbon taxes.
- However, they spend less in absolute value. Example:
  - a poor person makes 10,000€ per year and pays 60€ of taxes (0.6%);
  - a rich person makes 50,000€ per year and pays 100€ of taxes (0.2%).
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- How can we make a carbon tax policy progressive?
- Simple solution: redistribute the revenue lump-sum to everyone. In our example:
  - the total revenue collected is 60+100 = 160;
  - each person receives half of the revenue, *i.e.* 80€;
  - the net benefit of the policy is 20€ for the poor person, -20€ for the rich person.
- This strategy is sometimes called the Carbon Tax and Dividend.
- Obviously, other forms of transfers are possible and can make the policy more of less progressive.

Example: a carbon tax and dividend is progressive in France

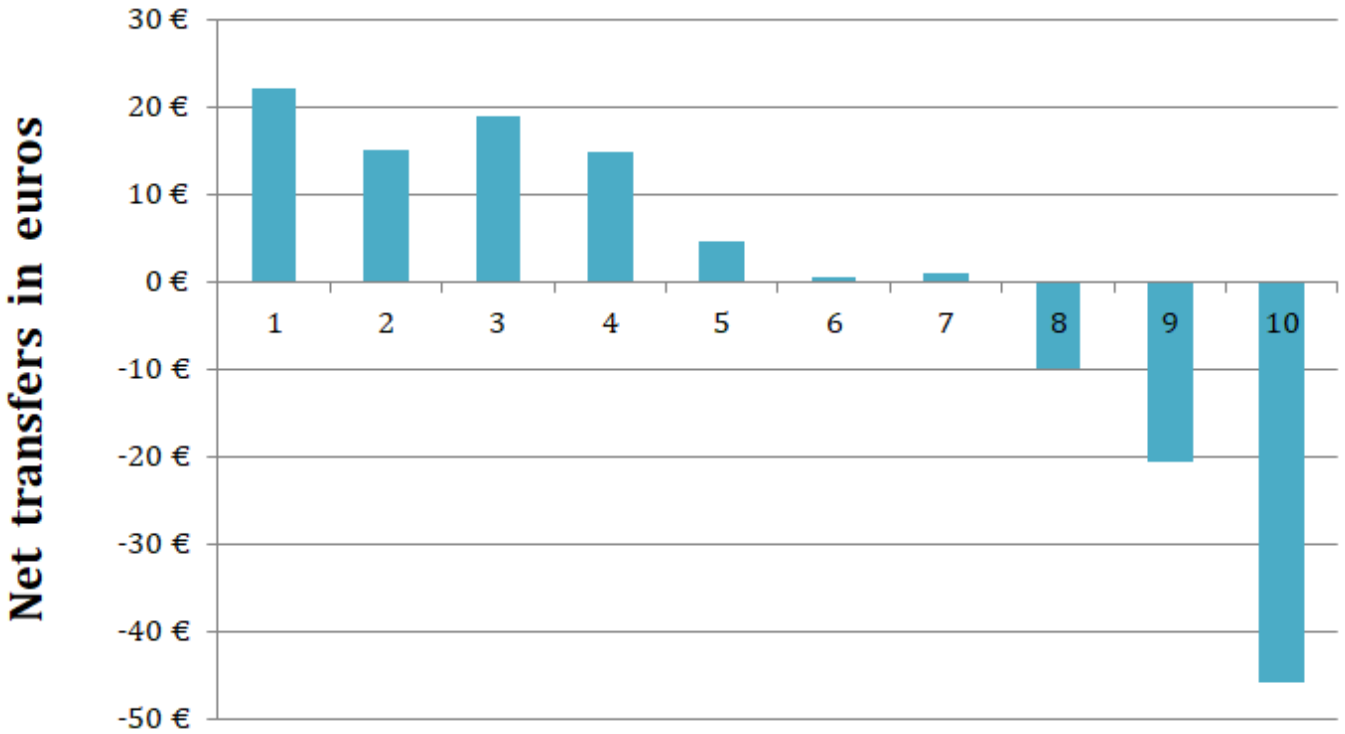

Figure: Net transfers from the French energy policy reform 2016-2018 after an hypothetical uniform revenue-recycling (from Douenne, 2020)

Another problem: multi-dimensional heterogeneity

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- The Carbon Tax and Dividend is a simple way to make a policy progressive. But can it solve all equity issues?
- If the impact of the carbon tax is solely determined by households' income, arguably yes.
- Problem: if households' carbon emissions differ *within* income groups, similarly poor people are differently affected by the tax but receive the same transfer. Example:
  - A poor person has no car and lives in a small apartment: pays 20€ for the tax, receives a 80€ dividend: net benefit of 60€.
  - Another poor person has a car and lives in a poorly insulated house in the countryside: pays 100€ for the tax, receives a 80€ dividend: net cost of 20€.
- With this "horizontal heterogeneity", no guarantee that a uniform lump-sum transfer will avoid substantial losses among poor households.

Example: horizontal heterogeneity in France

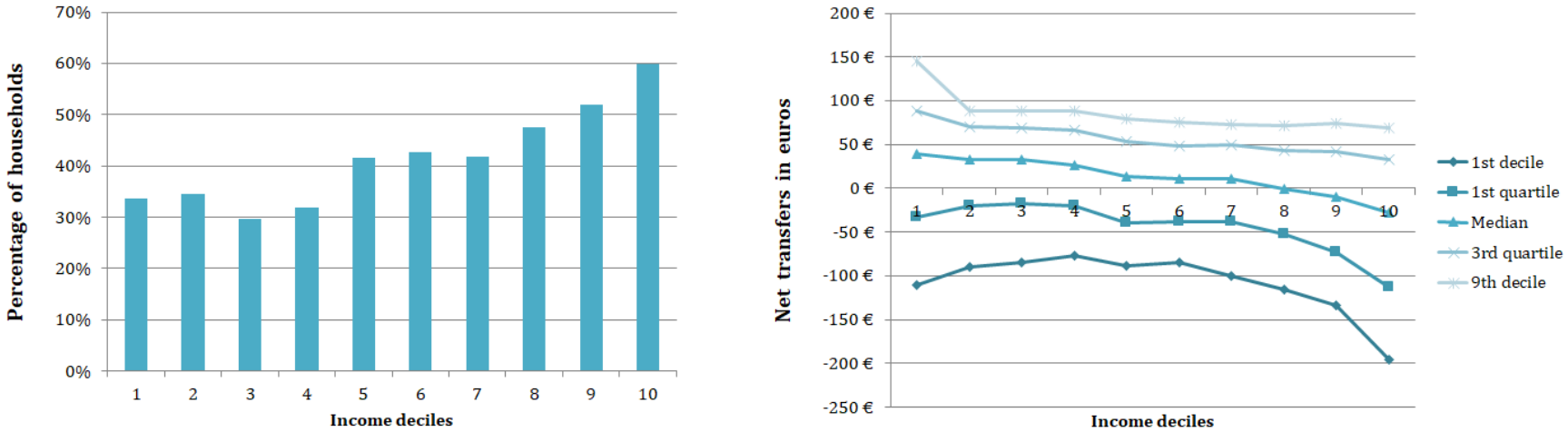

Figure: Share of households financially losing from the French energy policy reform 2016-2018 after an hypothetical uniform revenue-recycling (left), and distribution of net transfers per consumption unit (right) (from Douenne, 2020)

$\rightarrow$ About a third of the 10% poorest households would lose from a Carbon Tax and Dividend in France, 10% of them would lose more than 100€.

Solutions to horizontal heterogeneity

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How can we avoid so many losers among the poor?

- Option 1: make an even more progressive transfer.
  - How? Heavier burden on the middle class? Or concentrate everything on the richest? $\rightarrow$ Matter of political choice.
- Option 2: make more targeted transfers, *e.g.* depending on geographical location of the household.
  - Issues: in practice, impossible to make a precise targeting. Plus, the more we target losers, the less we incentivize polluters to change their habits.
- Option 3: use complementary policies to help people reduce their energy dependency.
  - Example: targeted programs with subsidies for home insulation.
  - Issues: targeting might again be difficult, and cost-effectiveness might be lower. Need to make sure that the distributional objectives are actually met.

Example: carbon tax with a progressive transfer in France

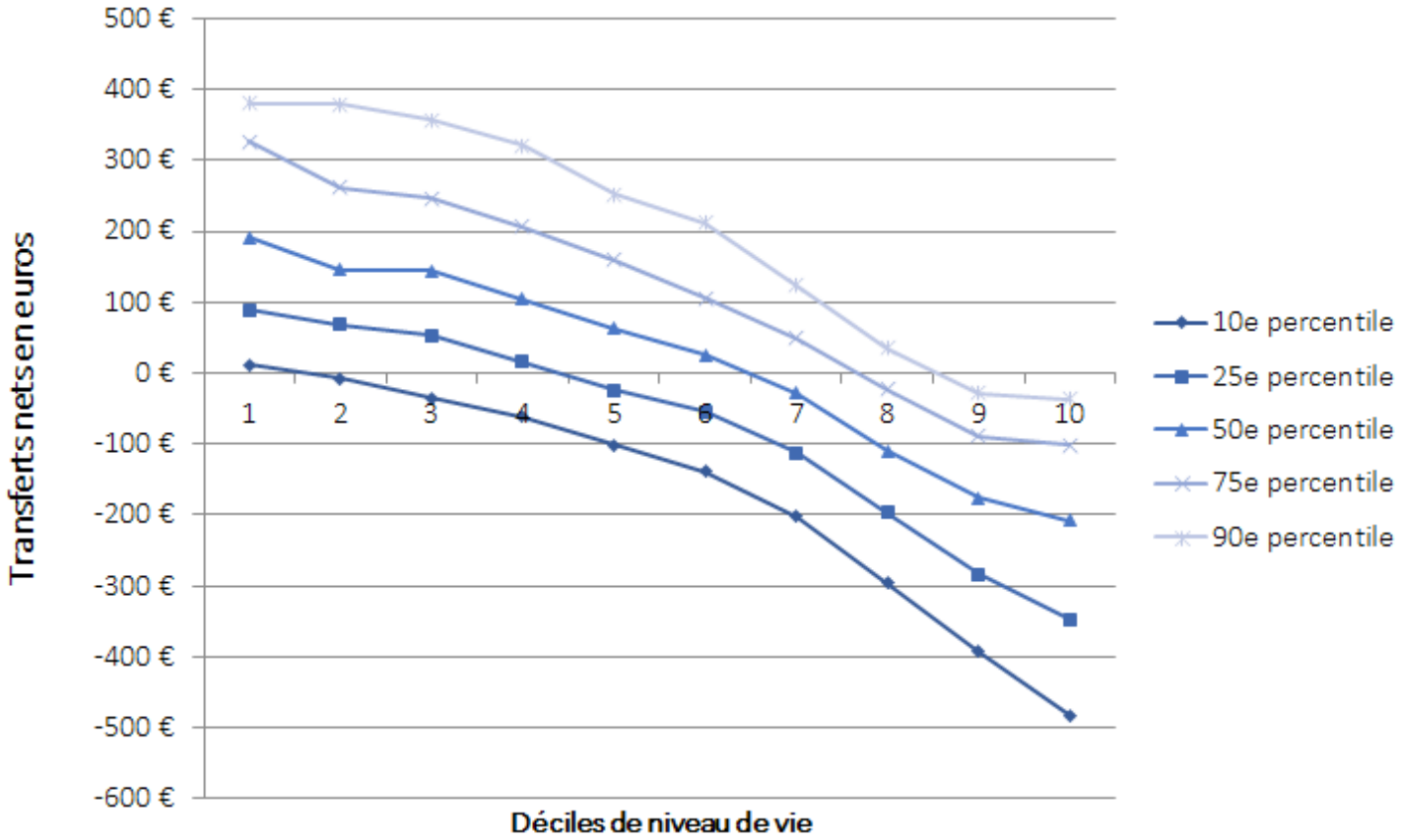

Figure: Distribution of net transfers per consumption unit from the French energy reform 2018-2022 after an hypothetical progressive revenue-recycling (from Bureau et al, 2019)

The impact through the income channel

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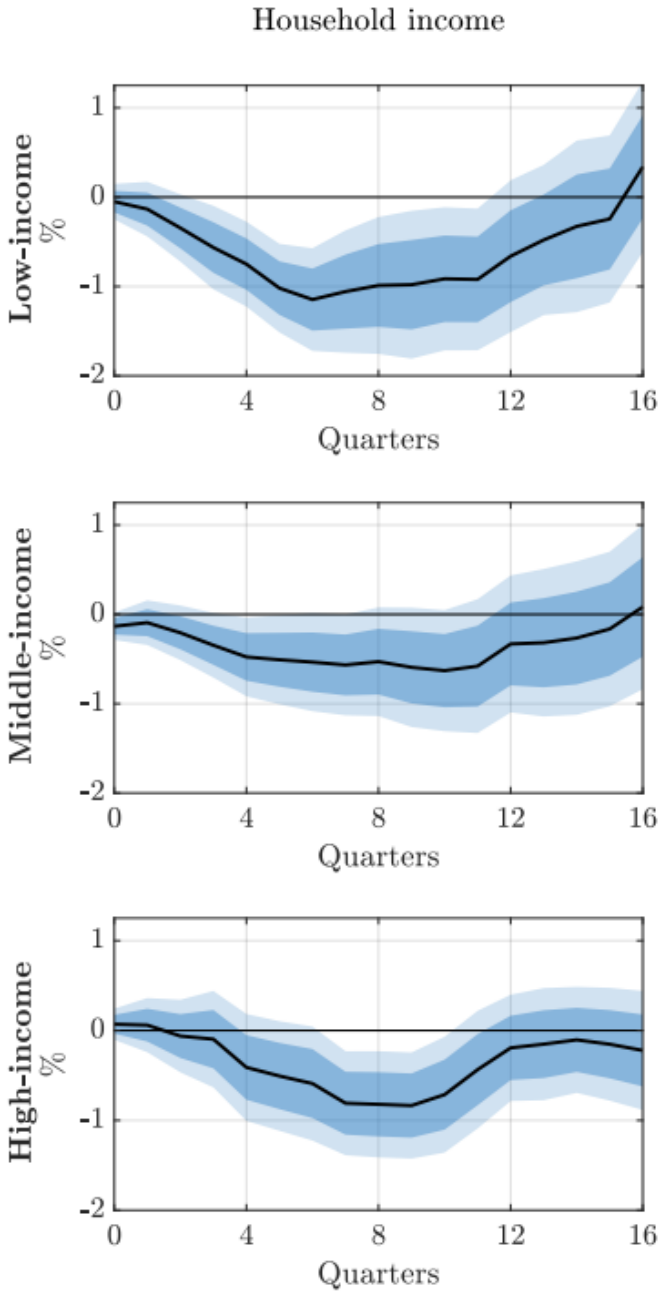
- Most studies focus on how climate policies affect people's purchasing power through the consumption channel.
- Other studies look at how it heterogeneously impacts people's income.
- Contrasting evidence!
- Some studies suggest high-income earners are more affected because:
  - returns to capital decrease more than returns to labor, and capital income represents a higher share of rich people's income;
  - transfers often adjust for inflation, and transfers represent a higher share of poor people's income.
- Other studies suggest that low-income earners are more affected because:
  - poor people are over-represented in sectors more impacted by energy prices.

$\rightarrow$ Net effect could be context-specific. More work is needed to better quantify these mechanisms.



- Source: Kanzig (2022). Studies impact of European carbon price (EU-ETS) on households in the U.K.
- Figures plot impulse responses of current total disposable household income to an increase in carbon price.
- The groups are: low-income (bottom 25%), middle-income (middle 50%) and high-income households (top 25%).
- Low-income households appear to be more affected than middle and high-income households.

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Are abatement subsidies less regressive than taxes?

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- Subsidies: instead of punishing bad behaviors, rewards good behaviors.
- Does this lead to more progressive outcomes?
- Depends on which specific behaviors are targeted.
- Two ways for households to pollute less:
  - to consume less;
  - to consume cleaner products.
- How do we reward lower consumption?

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- How do we reward lower consumption? $\rightarrow$ Tax consumption and rebate the tax revenue lump-sum to favor those consuming less. This is exactly the carbon tax and dividend strategy!
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- How do we reward lower consumption? $\rightarrow$ Tax consumption and rebate the tax revenue lump-sum to favor those consuming less. This is exactly the carbon tax and dividend strategy!
- How do we reward cleaner consumption? $\rightarrow$ Subsidize cleaner goods relative to dirtier ones.

In practice, cleaner goods are usually more expensive, hence subsidies tend to favor rich households.

Example: residential energy credits in the U.S.

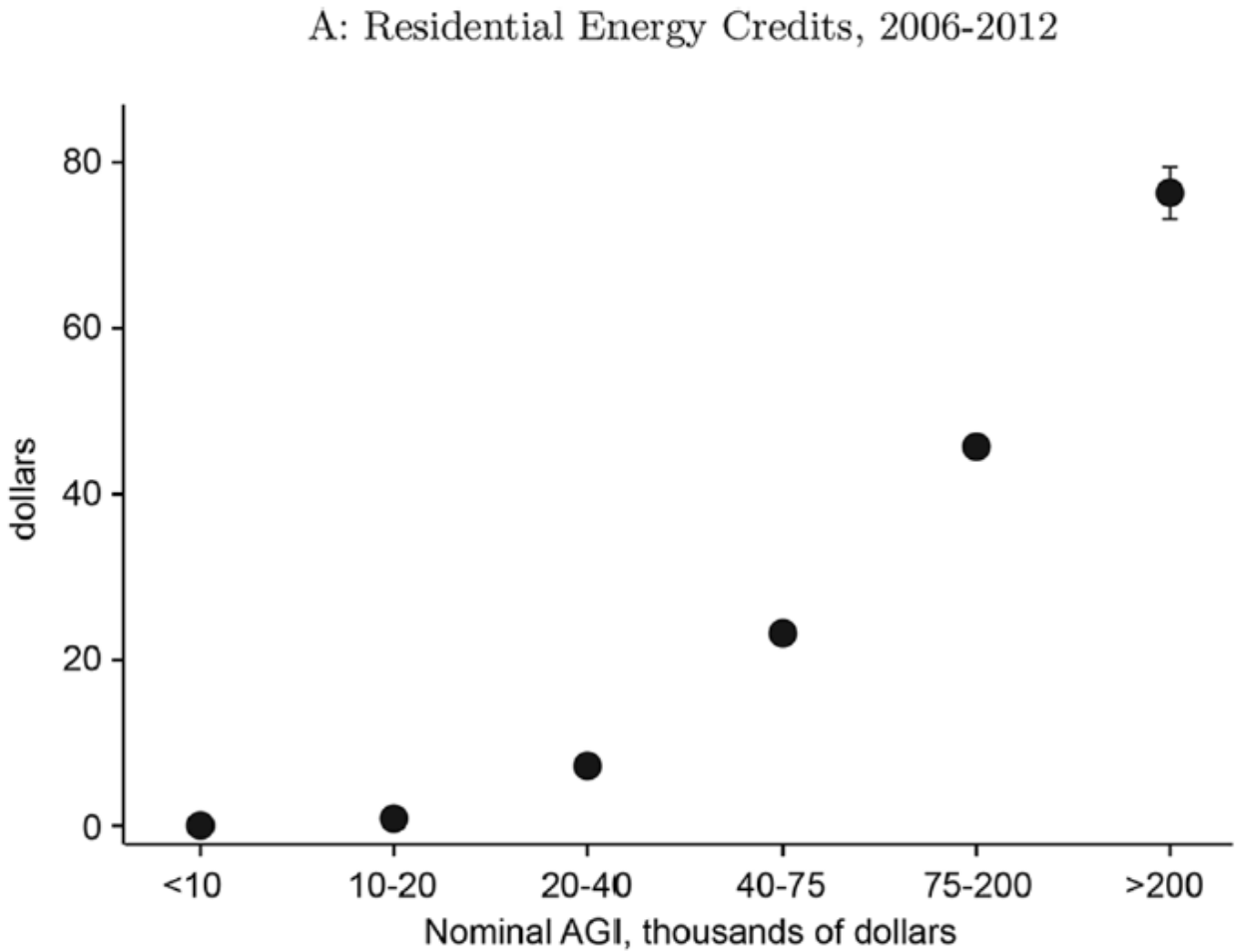

Fig. 5. Average Credit Per Return, by Adjusted Gross Income

$\rightarrow$ Residential energy tax credits (tax cuts conditional on home energy-efficiency improvements) mostly receive by richer households, partly because higher home ownership rate (from Borenstein and Davis, 2016).

Example: electric vehicles in the U.S.

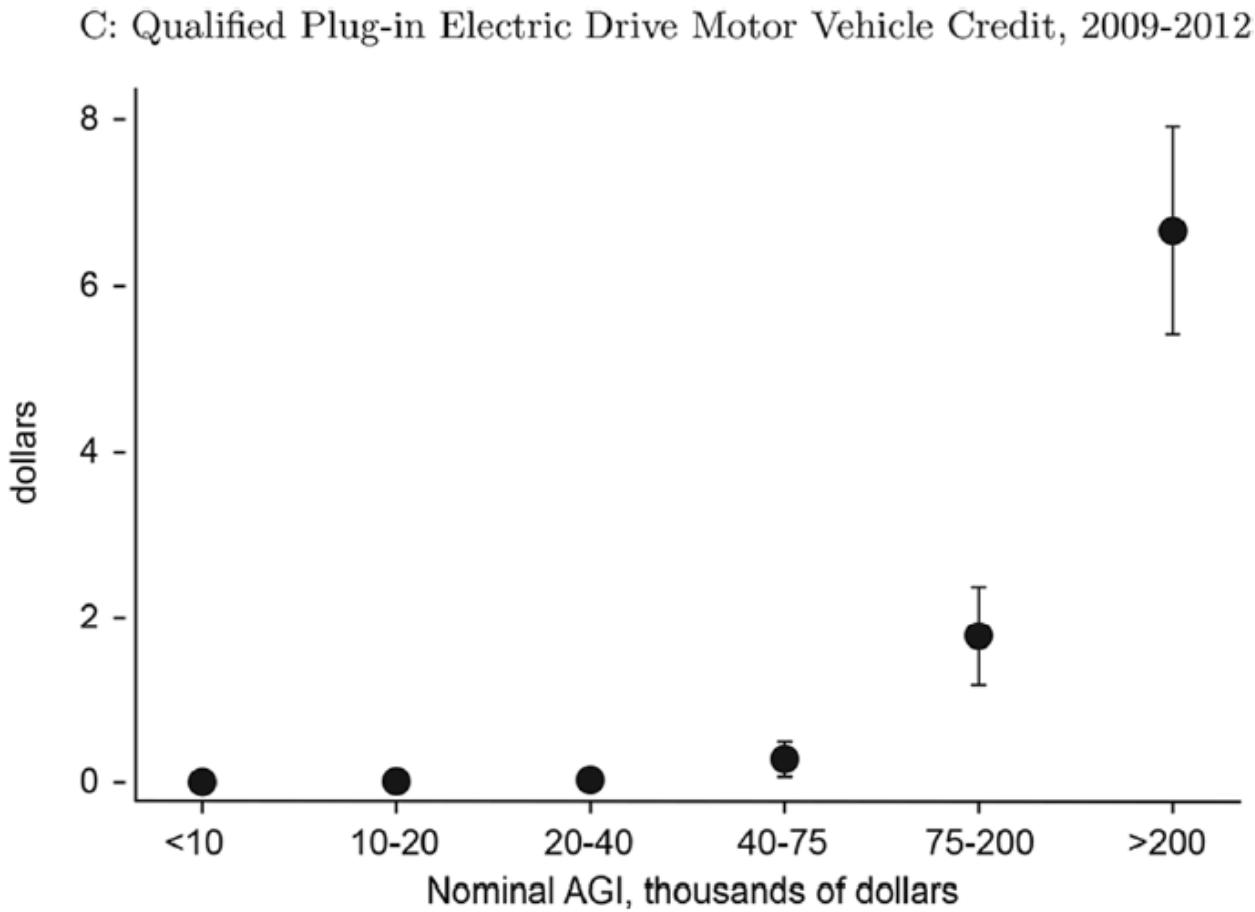

Fig. 5. Average Credit Per Return, by Adjusted Gross Income

→ For electric vehicles, tax credits even more concentrated at the top: the 20% richest households have received 90% them (from Borenstein and Davis, 2016). Much more regressive than a carbon tax!

Are pollution norms less regressive than taxes?

- The distributional effects of norms are difficult to assess.
- Norms have indirect effects on prices.
  - E.g. home insulation norms increase housing prices, vehicles' pollution standards increase vehicles' prices.
- Do poor households suffer more from these price increases, relative to those from a tax?
- Hard to say, likely very much context-specific.
- A few studies have examined vehicles' pollution standards in the U.S., suggesting they are more regressive than a gasoline tax (see Jacobsen, 2013; Davis & Knittel, 2019; Levinson, 2019).
- Still, more work is needed to better assess the distributional impact of pollution norms.

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Distributional effects between and within countries (1/2)

- So far, we have focused on the distributional effects of climate policies *within* countries.
- Main reason: most climate policies are actually implemented at the national level (exceptions include mechanisms such as the EU-ETS).
- Questions:
  - Are distributional effects from climate policies similar in all countries?
  - What would be the distributional effects from climate policies *between* countries?

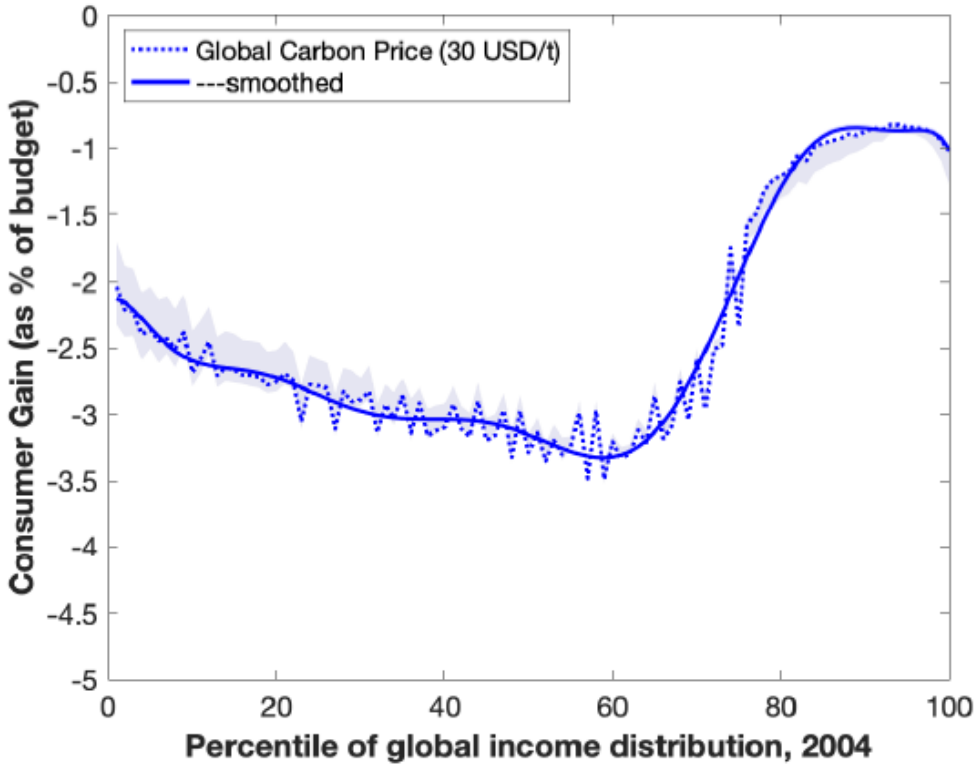
Distributional effects between and within countries (2/2)

- Answers to previous questions largely depend on the distribution of carbon production and consumption over the world:
  - the more a country consumes carbon, the more its purchasing power will be impacted through higher prices;
  - the more a country produces carbon, the more its purchasing power will be impacted through lower income.

- Distributional effects within countries largely depend on who in these countries work in carbon intensive industries, and who consumes carbon intensive products.

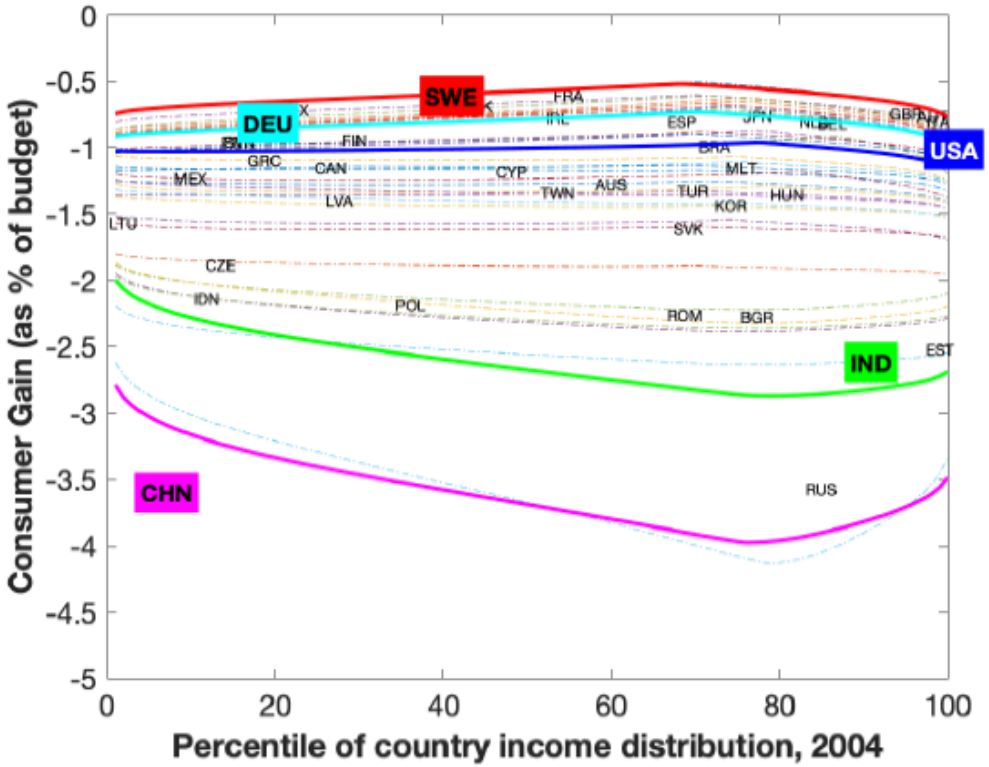
- Sager (2019): investigates the *global* distributional impact of carbon pricing through the consumption channel.

Figure 1: Global price of 30 USD per ton - Global distribution of consumer cost



Notes: This figure shows the global distribution of the consumer welfare effect under a global uniform carbon price of 30 USD per ton of CO_2 simulated at the end of 2004 (40 WIOD countries). The horizontal axis shows percentiles of the income/expenditure distribution across the 4.2 billion inhabitants of the 40 WIOD countries in 2004. The consumer gain is the average welfare effect, expressed as equivalent share of the total expenditure budget (dashed) and approximated with a 10th degree polynomial (solid). Shaded regions are 95% confidence intervals from 500 separate simulations, each using a different set of parameters drawn from the joint normal distributions from estimations (8), (9) and (10).

Figure 2: Global price of 30 USD per ton - Within-country consumer cost

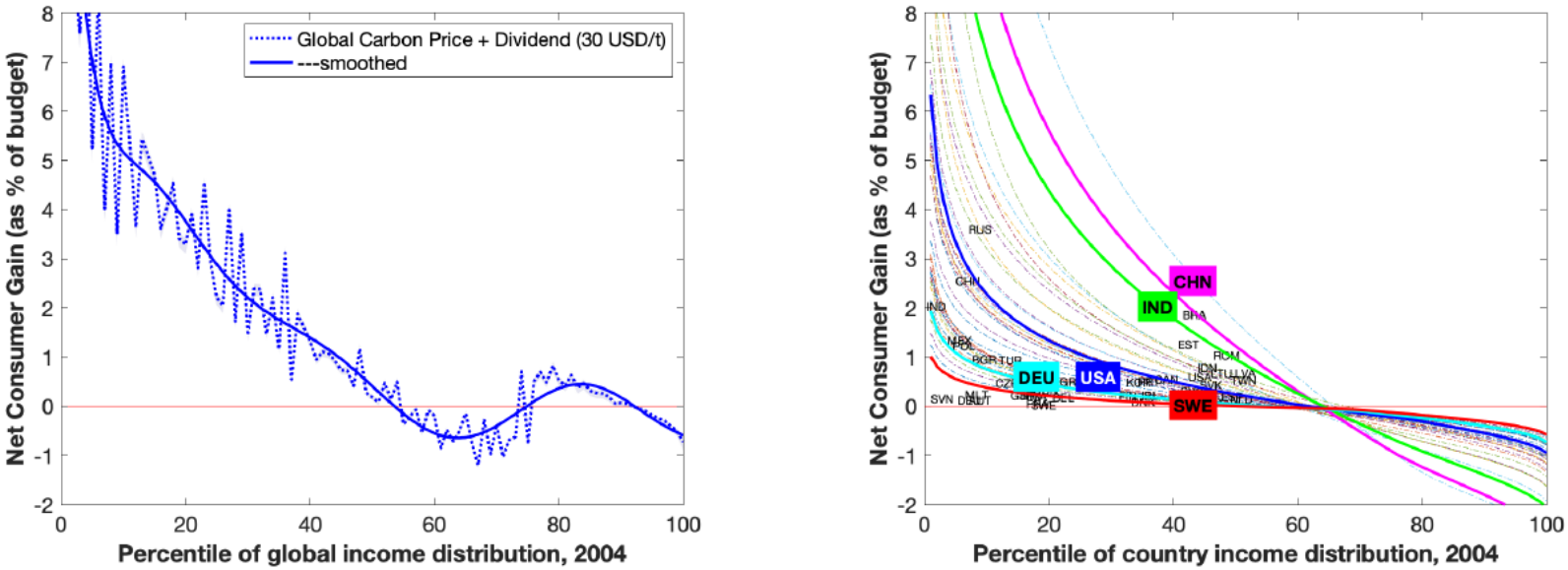


Notes: This figure shows the distribution of the consumer welfare effect in each country under a global uniform carbon price of 30 USD per ton of CO_2 simulated at the end of 2004 (40 WIOD countries). The horizontal axis shows percentiles of the income/expenditure distribution within each of the 40 WIOD countries in 2004. The consumer gain is the average welfare effect, expressed as equivalent share of the total expenditure budget.

Figure 3: Global price of 30 USD per ton and national carbon dividend - Consumer cost

(a) Global distribution

(b) Within-country distribution



Notes: Consumer welfare effect under a global uniform carbon price of 30 USD per ton of CO_2 simulated in 2004 (40 WIOD countries), net of the benefits from a per capita carbon dividend in each country. Revenue is collected and redistributed in the country where final consumption occurs. The horizontal axis shows percentiles of the income/expenditure distribution, both globally (Panel a) and within each of the 40 WIOD countries (Panel b) in 2004. Otherwise equivalent to Figure 1 (Panel a) and Figure 2 (Panel b).

→ A global Carbon Tax and Dividend would be progressive.

Global distributional effects of carbon pricing

The main takeaways from these results are:

- At the global level, poor households are on average more affected.
- The most affected are households in the middle of the global income distribution. The least affected are households at the top of this distribution.
- There is substantial cross-country heterogeneity, with China, Russia, and India expected to lose significantly more than the U.S. or most E.U. countries.
- Rebating the global carbon tax revenue lump-sum would lead to significant gains for the poorest households, and to a large share of winners in all countries.

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Heterogeneous benefits from climate mitigation

- So far, we have focused on heterogeneous economic impact of policies themselves.
- Yet, policies also impact people through the environmental improvements they lead to.
- These effects are heterogeneous, as people are heterogeneously exposed to climate change and environmental degradation.
- Do environmental improvements benefit more the rich or the poor?

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  - Within countries: poor people are also likely more exposed to climate change.
- Why?

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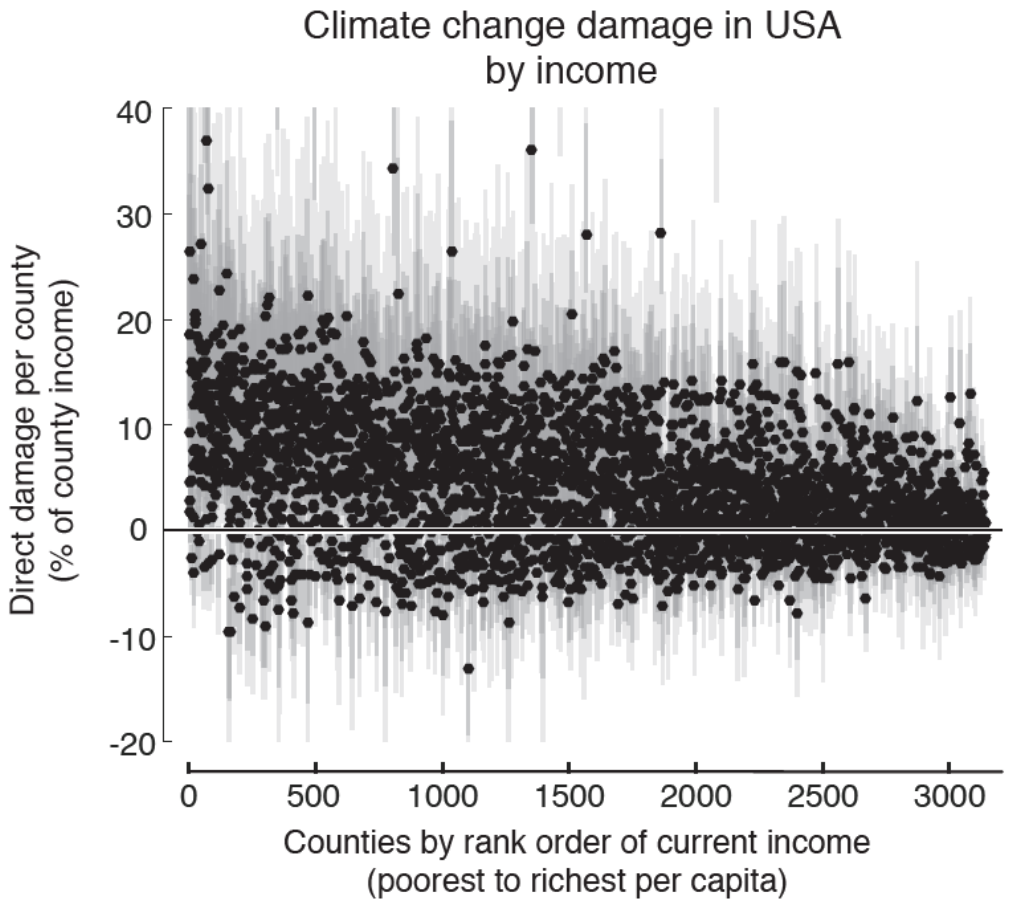
- Do environmental improvements benefit more the rich or the poor?
  - Across countries: people living in poor countries suffer (on average) more from climate change $\rightarrow$ They benefit more from climate mitigation.
  - Within countries: poor people are also likely more exposed to climate change.
- Why? A non-exhaustive list of reasons:
  - Poor people live in (on average) warmer places, hence temperature increases are more damaging.
  - Coping with higher temperatures requires adaptation, which might be costly.
  - Outside jobs tend to be more low-skilled.

Climate damages as a function of income



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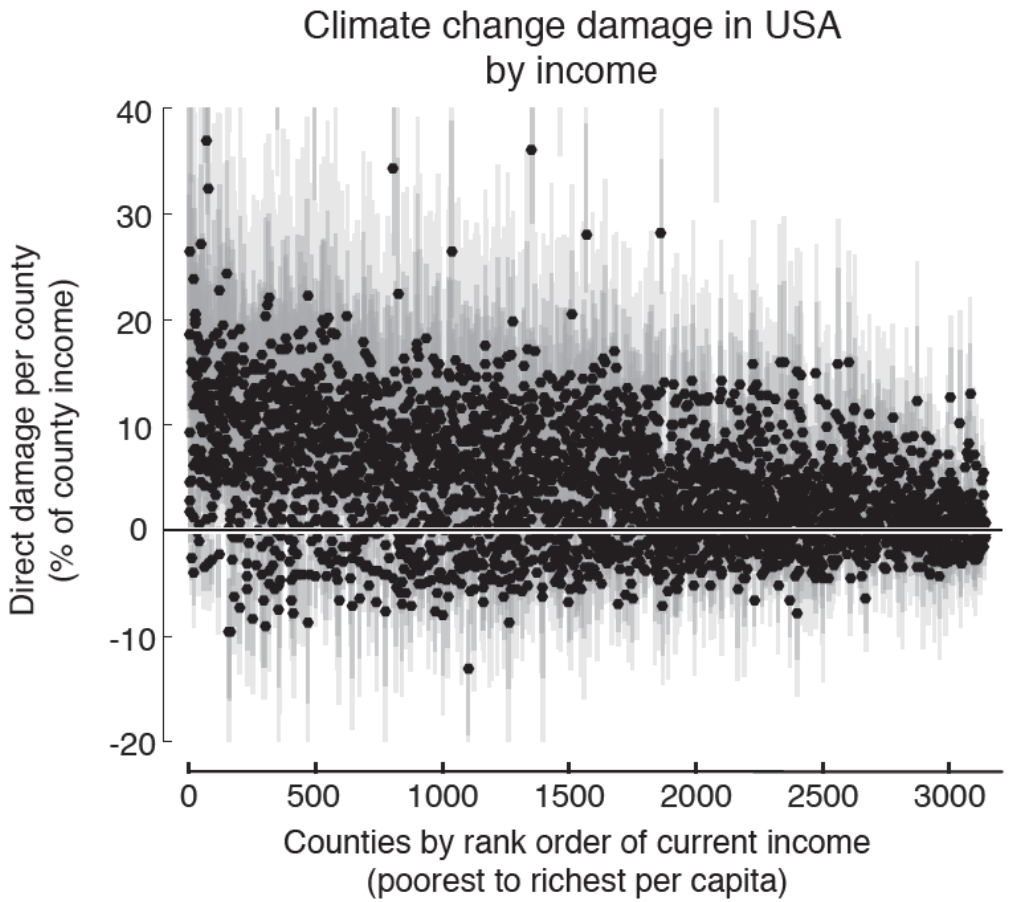
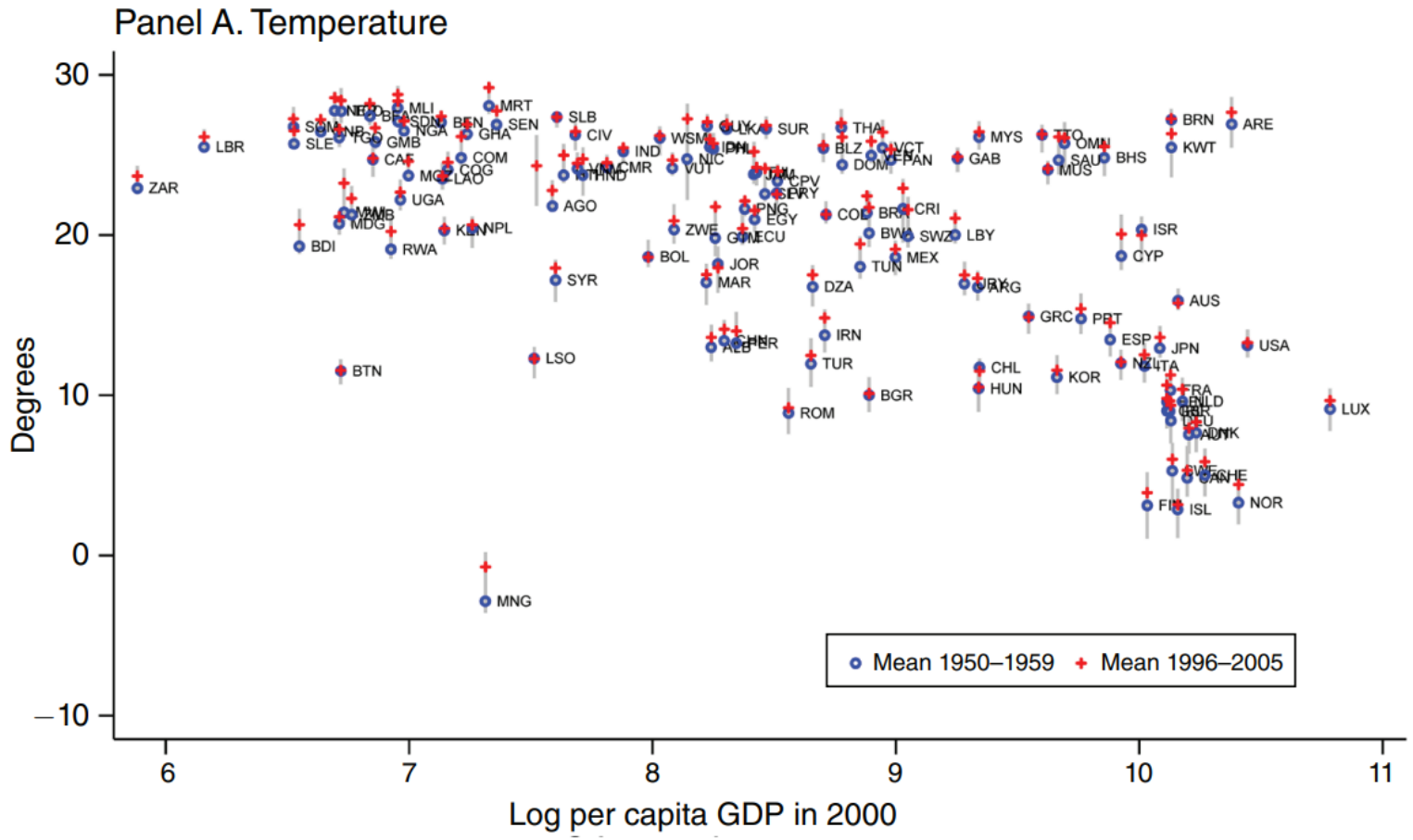


$\rightarrow$ On average, richer U.S. counties expected to suffer less from direct climate damages (from Hsiang et al, 2019).

Temperature and GDP — Cross-sectional link



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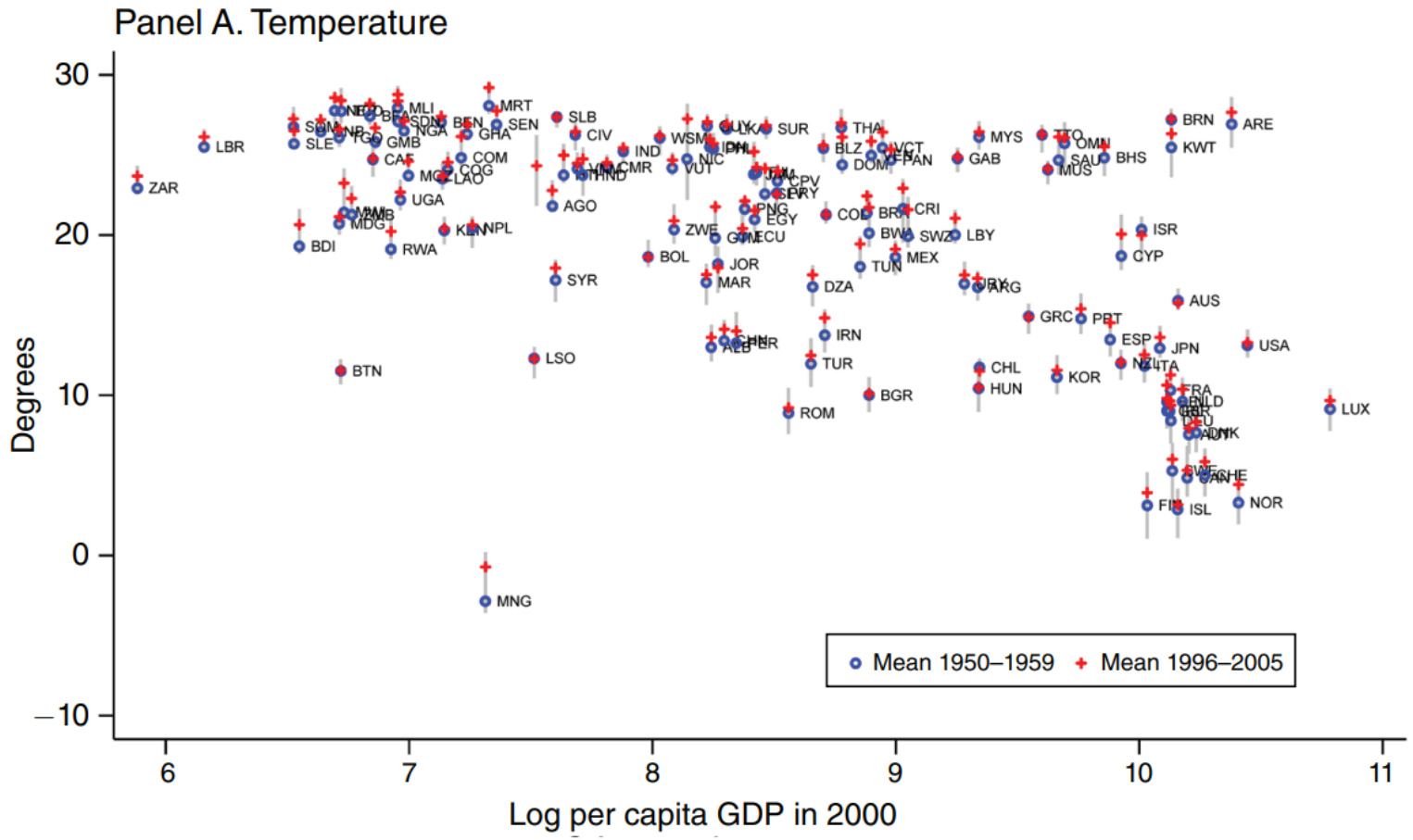

→ On average, poorer countries have higher temperatures. Also suggests that they will probably be more sensitive to temperature increases (from Dell et al, 2012).

TABLE 2—MAIN PANEL RESULTS

Dependent variable is the annual growth rate	(1)	(2)	(3)	(4)	(5)
Temperature	−0.325	0.261	0.262	0.172	0.561*
	(0.285)	(0.312)	(0.311)	(0.294)	(0.319)
Temperature interacted with...					
Poor country dummy		−1.655***	−1.610***	−1.645***	−1.806***
		(0.485)	(0.485)	(0.483)	(0.456)
Hot country dummy				0.237	
				(0.568)	
Agricultural country dummy					−0.371
					(0.409)
Precipitation			−0.083*	−0.228***	−0.105**
			(0.050)	(0.074)	(0.053)
Precipitation interacted with...					
Poor country dummy			0.153*	0.160**	0.145*
			(0.078)	(0.075)	(0.087)
Hot country dummy				0.185**	
				(0.078)	
Agricultural country dummy					0.010
					(0.085)
Observations	4,924	4,924	4,924	4,924	4,577
Within R^2	0.00	0.00	0.00	0.01	0.01
R^2	0.22	0.22	0.22	0.22	0.24
Temperature effect in poor countries		−1.394***	−1.347***	−1.473***	−1.245***
		(0.408)	(0.408)	(0.440)	(0.463)
Precipitation effect in poor countries			0.069	−0.0677	0.0401
			(0.058)	(0.073)	(0.089)

Notes: All specifications use WDI data and include country FE, region × year FE, and poor × year FE. Robust standard errors are in parentheses, adjusted for clustering at parent-country level. Sample includes all countries with at least 20 years of growth observations. Poor is defined as a dummy for a country having below median PPP GDP per capita in its first year in the data. Hot is defined as a dummy for a country having above median average temperature in the 1950s. Agricultural is defined as a dummy for a country having above median share of GDP in agriculture in 1995. Temperature is in degrees Celsius and precipitation is in units of 100 mm per year.

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*Significant at the 10 percent level.

→ Higher temperatures lead to lower GDP growth. Effect fully driven by poor countries (from Dell et al, 2012).

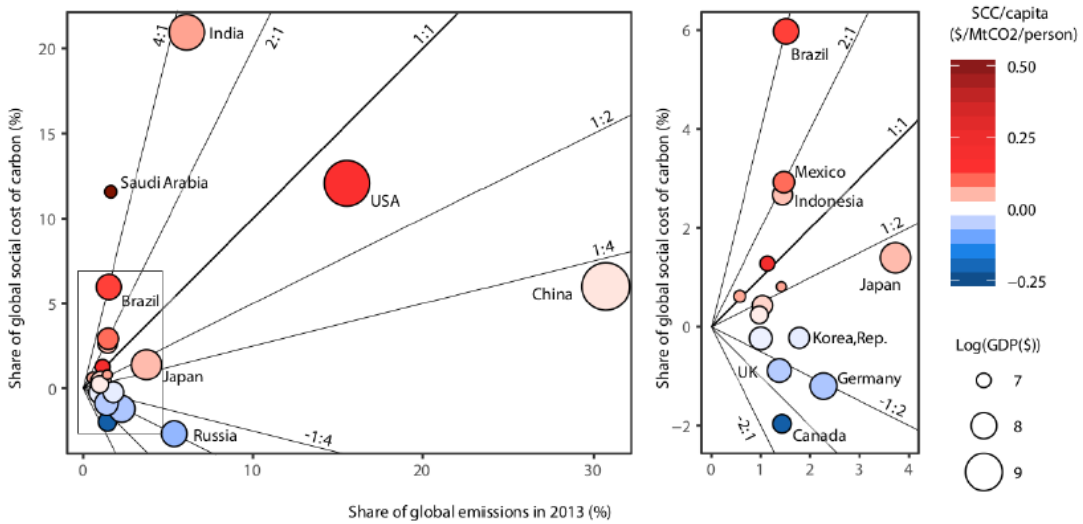
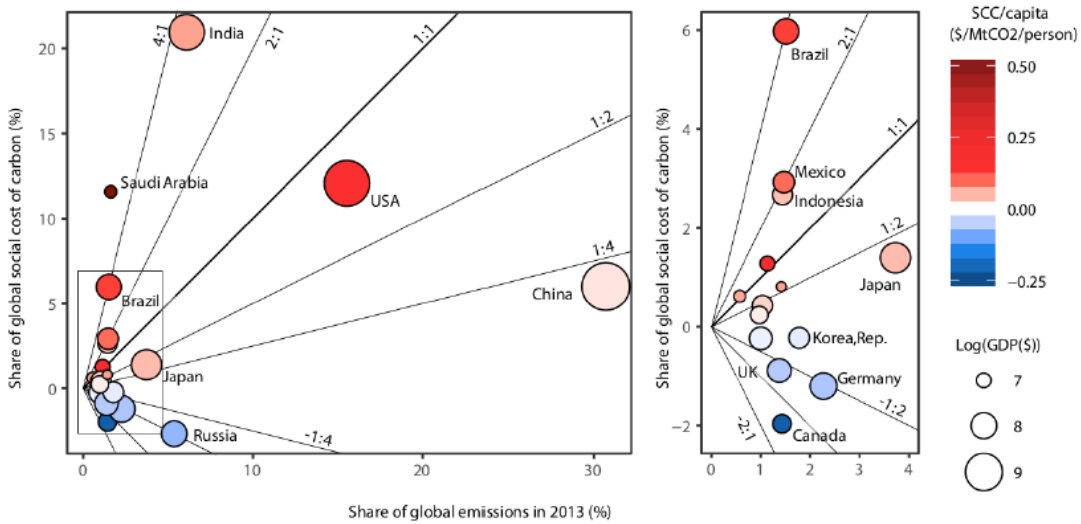


Figure 4 | 'Winners' and 'Losers' of climate change among G20 nations. *Country-level shares of global SSC (i.e., CSCC/GSCC) versus shares of 2013 CO2 emissions. CSCC is the median estimate with growth adjusted discounting for SSP2/RCP6.0, BHM-SR reference specification (short run, pooled countries). Bubble size corresponds to the country's GDP (log(USD)) and the color indicates per-capita CSCC ($/MtCO2/person). Diagonal lines show the ratio of global SCC share to emissions share. Ratios greater than 1:1 indicate that a country's share of global SSC exceeds it share of global emission. Grey box in left panel indicates the bounds of the detail shown in right panel.*



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$\rightarrow$ If countries internalized only their own damages, their own SCC would be very heterogeneous: US and China expected to lose a lot from climate change, Russia and other northern countries to gain (from Ricke et al, 2018).

Concluding remarks

- In developed economies: poor households spend a larger share of their income in carbon intensive goods, such as energy. As a result, they are typically disproportionately impacted by climate policies.
- Taxes, subsidies, and norms all tend to be regressive. However, taxes offer the possibility to redistribute the revenue in a progressive way.
- Still, horizontal heterogeneity makes it difficult to avoid having many losers among the poor.
- The distributional impacts may vary from a country to another, as well as between countries.
- Climate policies are likely to benefit the poorest people in the poorest countries, as they are the most exposed to climate change.

$\rightarrow$ Equity and environmental objectives could go hand-in-hand, provided policies are designed accordingly.