Public Economics for Public Policy
Part III: Externalities, and Climate Change

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Sciences Po *MPA 2023-2024*

Today's Lecture

Externalities

Theory – Market Failure

Coase Theorem

Corrective Taxation

Quantity Regulation

Climate Change

Understanding Attitudes toward Climate Policies

Externalities

Market failure: A problem that violates one of the assumptions of the 1st welfare theorem and causes the market economy to deliver an outcome that does not maximize efficiency

Externality: Externalities arise whenever the actions of one economic agent directly affect another economic agent outside the market mechanism

Externality example: a steel plant that pollutes a river used for recreation

Not an externality example: a steel plant uses more electricity and bids up the price of electricity for other electricity customers

Externalities are one important case of market failure

Negative production externality: When a firm's production reduces the well-being of others who are not compensated by the firm.

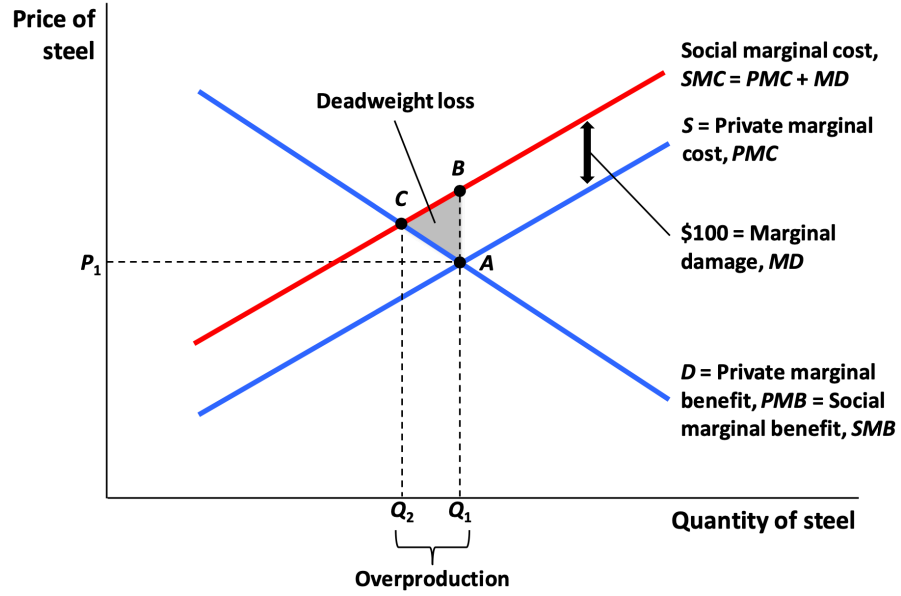
Private marginal cost (PMC): The direct cost to producers of producing an additional unit of a good

Marginal Damage (MD): Any additional costs associated with the production of the good that are imposed on others but that producers do not pay

Social marginal cost (SMC = PMC + MD): The private marginal cost to producers plus marginal damage

Example: steel plant pollutes a river but plant does not face any pollution regulation (and hence ignores pollution when deciding how much to produce)

Economics of Negative Production Externalities: Steel Production



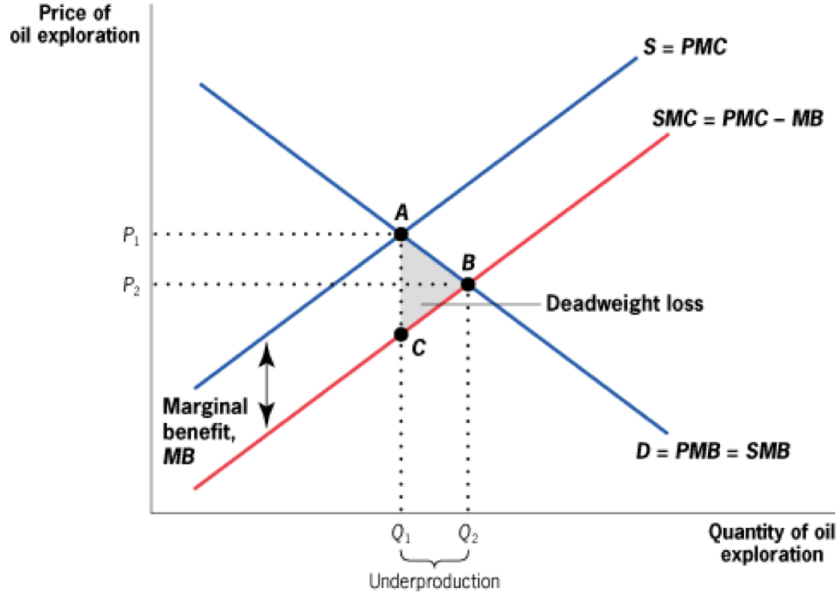
Negative consumption externality: When an individual's consumption reduces the well-being of others who are not compensated by the individual.

Private marginal benefit (PMB): The direct benefit to consumers of consuming an additional unit of a good by the consumer.

Social marginal benefit (SMB): The private marginal benefit to consumers plus any costs associated with the consumption of the good that are imposed on others

Example: Using a car and emitting carbon contributing to global warming

Economics of Positive Externalities: Oil Exploration Market



Positive production externality: When a firm's production increases the well-being of others but the firm is not compensated by those others.

Example: Beehives of honey producers have a positive impact on pollination and agricultural output

Positive consumption externality: When an individual's consumption increases the well-being of others but the individual is not compensated by those others.

Example: Beautiful private garden that passers-by enjoy seeing

Externality Theory: Market Outcome is Inefficient

With a free market, quantity and price are such that $PMB = PMC$

Social optimum is such that $SMB = SMC$

$\Rightarrow$ Private market leads to an inefficient outcome (1^{st} welfare theorem does not work)

Negative production externalities $\rightarrow$ over production (*SMC* curve above *PMC* curve)

Positive production externalities $\rightarrow$ under production (*SMC* curve below *PMC* curve)

Negative consumption externalities $\rightarrow$ over consumption (*SMB* curve lies below *PMB* curve)

Positive consumption externalities: $\rightarrow$ under consumption (*SMB* curve lies above *PMB* curve)

Key question raised by Ronald Coase (famous Nobel Prize winner Chicago libertarian economist):

Are externalities really outside the market mechanism?

Internalizing the externality: When either private negotiations or government action lead the price to the party to fully reflect the external costs or benefits of that party's actions.

Coase Theorem (Part I): When there are well-defined property rights and costless bargaining, then negotiations between the party creating the externality and the party affected by the externality can bring about the socially optimal market quantity.

Coase Theorem (Part II): The efficient quantity for a good producing an externality does not depend on which party is assigned the property rights, as long as someone is assigned those rights.

Coase Theorem Example

Firms producing steel pollute a river enjoyed by swimmers. If the firms ignore swimmers, there is too much pollution

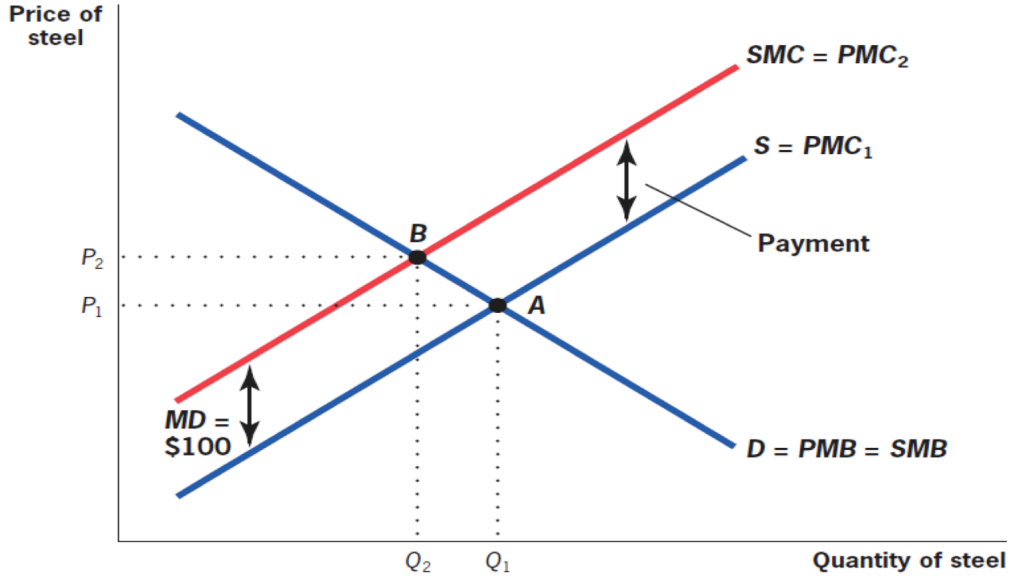
1. Swimmers own river: If river is owned by swimmers, then swimmers can charge firms for polluting the river. They will charge firms the marginal damage (*MD*) per unit of pollution. (Shifts up the PMC of the firm to the level of *SMC*).

   > Why price pollution at *MD*? If price is above *MD*, swimmers would want to sell an extra unit of pollution and get hit by pollution damage *MD*, so price must fall. *MD* is the equilibrium efficient price in the newly created pollution market.

2. Firms own river: If river is owned by firms, then swimmers are willing to pay firms MD for each unit of steel it does NOT produce. This increases the firms' cost of producing each unit of steel. Their cost shifts from *PMC* to $SMC = PMC + MD$ for each quantity of steel produced.

Final level of pollution will be the same in 1) and 2)

The Solution: Coasian Payments



Problems with the Coasian Solution – I

In practice, the Coase theorem is unlikely to solve many of the types of externalities that cause market failures.

1) The assignment problem: Can you assign blame to one single entity (e.g., a long river with many polluting firms); can you assign the exact damage (how is MD really measured?); who gets the property rights? In cases where externalities are caused by and affected many agents (e.g. global warming), assigning property rights is difficult

$\Rightarrow$ Coasian solutions are likely to be more effective for small, localized externalities than for larger, more global externalities involving large number of people and firms

2) The holdout problem: Shared ownership of property rights gives each owner power over all the others (because joint owners have to all agree to the Coasian solution).

Imagine the swimmers who own property rights for a clean river. After 99 swimmers have agreed to receive their compensation from the firm, the 100th swimmer has an incentive to ask for more (to hold out). Anticipating this, all swimmers should try to hold out.

$\Rightarrow$ As with the assignment problem, the holdout problem would be amplified with an externality involving many parties.

3) The Free Rider Problem: When an investment has a personal cost but a common benefit, individuals will underinvest.

In the swimmers' example, if property rights are assigned to the firm, the 100th swimmer has no incentive to pay for their share of pollution reduction, as the pollution is almost at socially optimal level and the damage caused by the last unit of pollution that they have to pay for is shared among all swimmers.

4) Transaction Costs and Negotiating Problems: The Coasian approach ignores the fundamental problem that it is hard to negotiate when there are large numbers of individuals on one or both sides of the negotiation.

This problem is amplified for an externality such as global warming, where the potentially divergent interests of billions of parties on one side must be somehow aggregated for a negotiation.

Problems with the Coasian Solution: Bottom Line

Ronald Coase's insight that externalities can sometimes be internalized was useful.

It provides the competitive market model with a defense against the onslaught of market failures.

It is also an excellent reason to suspect that the market may be able to internalize some small-scale, localized externalities.

It won't help with large-scale, global externalities, where only a "government" can successfully aggregate the interests of all individuals suffering from externality

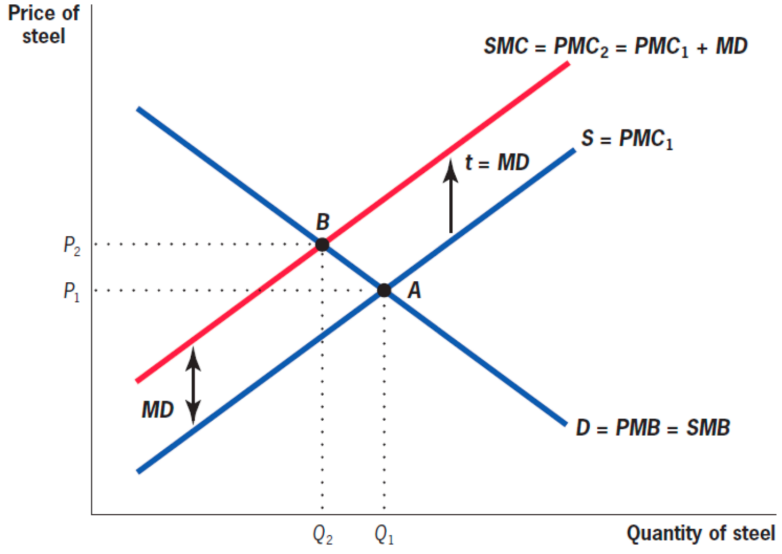
Public Sector Remedies for Externalities

Public policy makers employ two types of remedies to resolve the problems associated with negative externalities:

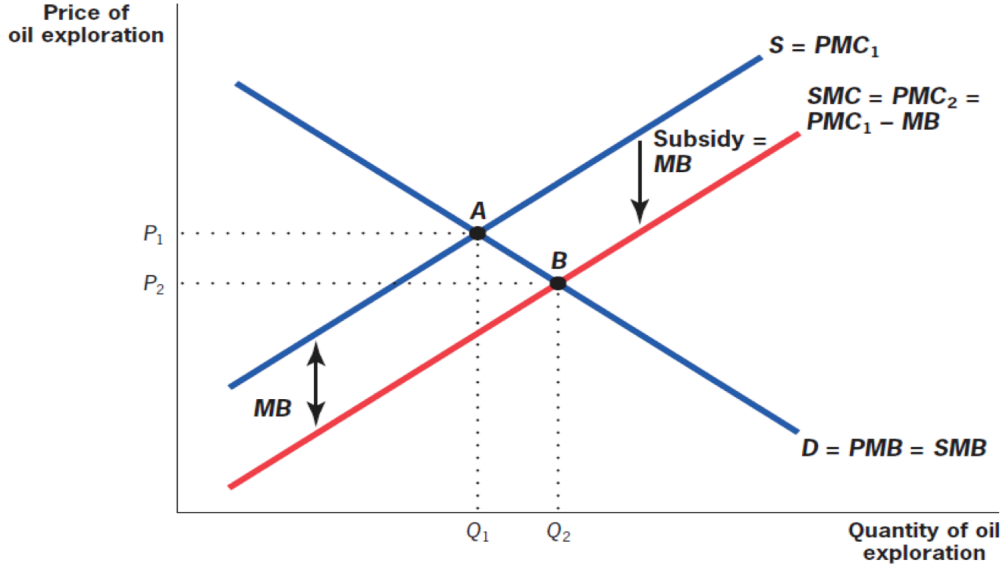
1. **quantity regulation**: government limits use of externality producing chemicals. Example CFCs [chlorofluorocarbons] that deplete ozone layer
2. **corrective taxation**: corrective tax or subsidy equal to marginal damage per unit. Example: Carbon tax to fight global warming due to CO_2 emissions

1) and 2) can be combined with tradable emissions permits to firms that can then be traded (cap-and-trade for carbon emissions)

Corrective Taxation



Corrective Subsidies



Understanding Difference between Tax and Quantity Regulation – I

To understand the differences between price and quantity approaches to pollution reduction, shift focus from the market for a good (e.g., steel) to the “market” for pollution reduction (see next slide).

Pollution reduction can happen in many ways, other than reducing quantity of the good produced (abatement technologies, changing production technology).

Horizontal axis measures extent of *pollution reduction* undertaken by a plant; a value of zero indicates that the plant is not engaging in any pollution reduction.

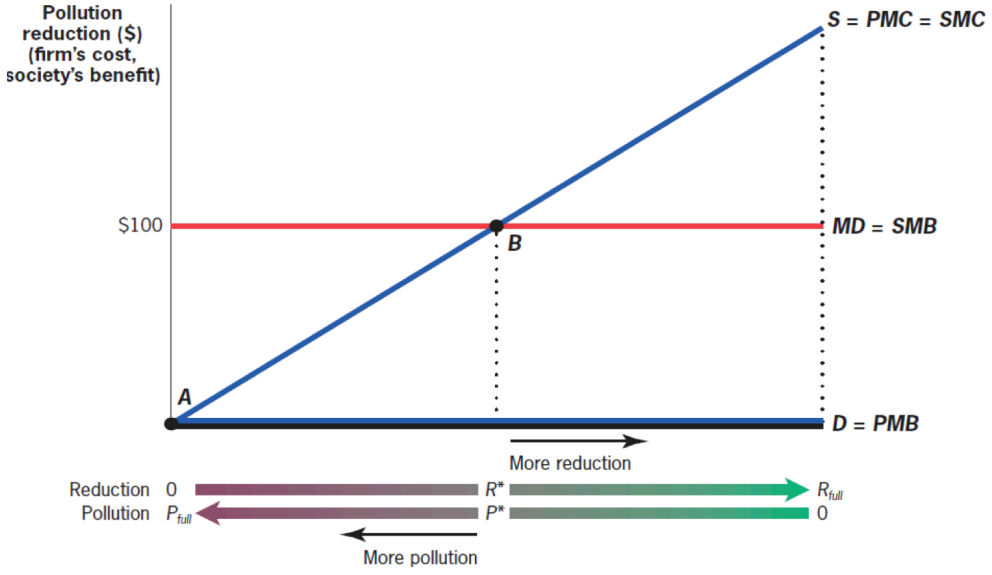
Axis also measures amount of pollution: more pollution reduction and less pollution as you move to the right.

Vertical axis represents cost of pollution reduction to the plant, or the benefit of pollution reduction to society. MD curve represents the marginal damage that is averted by addition-al pollution reduction = the social marginal benefit of pollution reduction (drawn flat here)

Private marginal benefit of pollution reduction is zero.

PMC curve represents plant's private marginal cost of reducing pollution: slopes upward because each additional unit of reduction become more expensive, until it is incredibly expensive to have a completely pollution-free production process. PMC = SMC since pollution reduction causes no externality.

Distinction between Prices and Quantity Approaches – Basic Model



In this Simple Model, Tax and Quantity Regulation are Equivalent

Can impose a tax per unit of pollution of \$100 or can mandate the quantity of reduction to be R^* (or the amount of pollution to be P^*) on the slide above.

But what happens if we do not know the firms' costs of abating pollution?

First, Imagine the *MD* Curve is Quite Flat

Example: global warming. What does it mean to have a flat MD curve? It means the exact amount of pollution does not matter that much for the damage it causes.

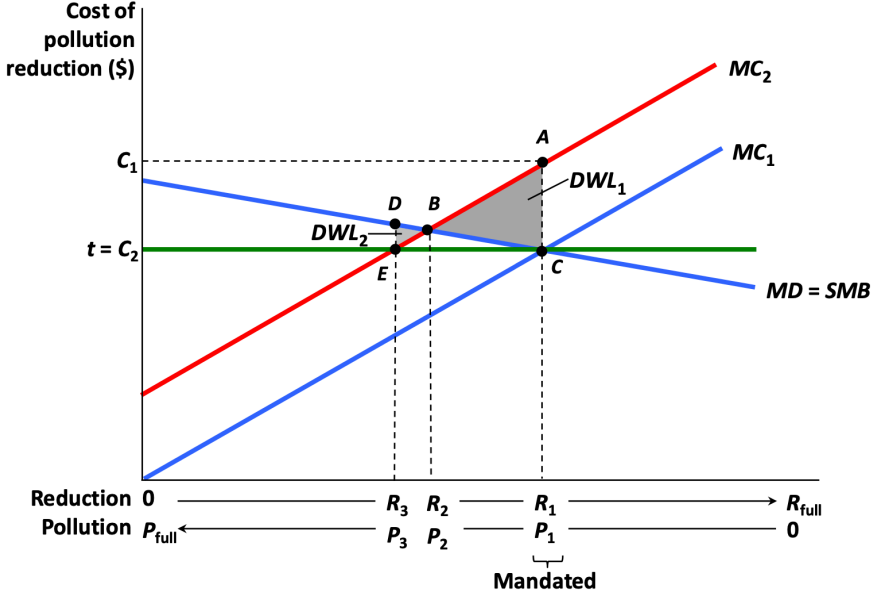
Imagine costs could be either MC_1 or MC_2. If the government thinks costs are MC_1, it should impose a tax $t = C_2$, such that the curve MC_1 and the line $t = C_2$ intersect exactly where the MC_1 and MD curves intersect.

Alternatively, if the government decided to impose a quantity regulation, it would impose pollution levels P_1, or reduction levels R_1.

But suppose now that the firm turns out to have costs MC_2. The DWL from the tax is triangle BDE. The DWL from the quantity regulation is ABC. The loss from the quantity regulation is larger when the MD curve is flat. The firm is forced to abate too much pollution, which is too costly.

Intuition: if it's not critical to get the quantity exactly right, it's better to let the firm choose the quantity (since it knows its costs) and impose a tax.

Uncertainty about Costs of Reduction – Case 1, Flat *MD* Curve (Global Warming)



Next, Imaginge the *MD* Curve is Quite Steep

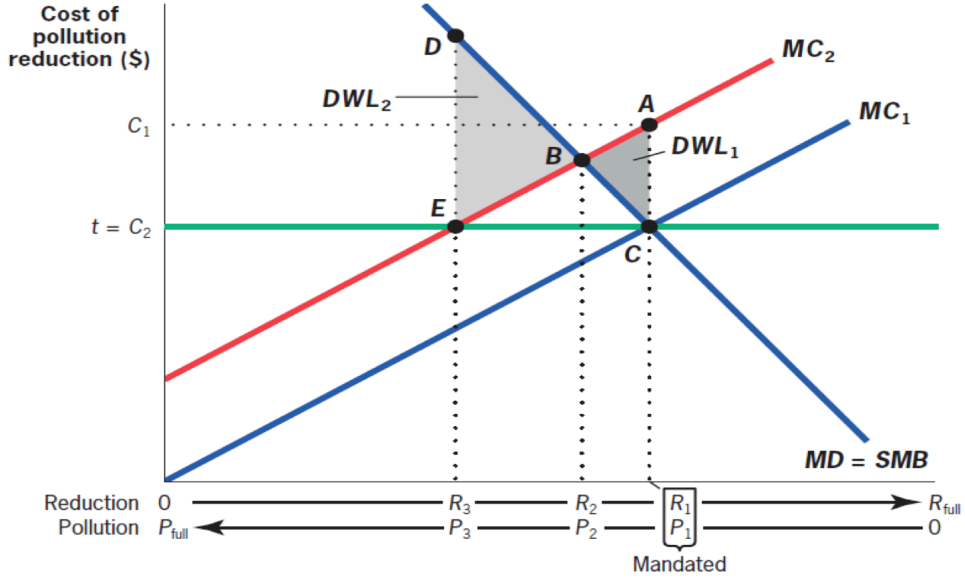
Example: Nuclear leakage. Each additional unit of pollution could cost many lives.

Going through the same steps, suppose the government imposes a tax or a quantity regulation, thinking that the cost is M_1, but the cost turns out to be MC_2.

The DWL from the tax (BDE) is much larger than the DWL from the quantity regulation (ABC).

Intuition: In this case, it is critical to get the quantity right. Even if we make the firm abate too much or too little relative to its costs.

Uncertainty about Costs of Reduction – Case 2, Steep *MD* Curve (Nuclear Leakage)



Two differences between corrective taxes and tradable permits (carbon tax vs. cap-and-trade in the case of CO_2 emissions)

1) Uncertainty in marginal costs just discussed: With uncertainty in costs of reducing pollution, taxes preferable when MD curve is flat. Tradable permits are preferable when MD curve is steep.

2) Initial allocation of permits: If the government sells them to firms, this is equivalent to the tax

If the government gives them to current firms for free, this is like the tax + large transfer to initial polluting firms.

Acid rain due to contamination by emissions of sulfur dioxide (SO_2) and nitrogen oxide (NO_x).

1970 Clean Air Act: Landmark federal legislation that first regulated acid rain-causing emissions by setting maximum standards for atmospheric concentrations of various substances, including SO_2.

The 1990 Amendments and Emissions Trading:

SO_2 allowance system: The feature of the 1990 amendments to the Clean Air Act that granted plants permits to emit SO_2 in limited quantities and allowed them to trade those permits.

Empirical Example: Effects of Clean Air Act of 1970

How does acid rain (or SO2) affect health?

Observational approach: relate mortality in a geographical area to the level of particulates (such as SO2) in the air

Problem: Areas with more particulates may differ from areas with fewer particulates in many other ways, not just in the amount of particulates in the air

Chay and Greenstone (2003) use clean air act of 1970 to resolve the causality problem:

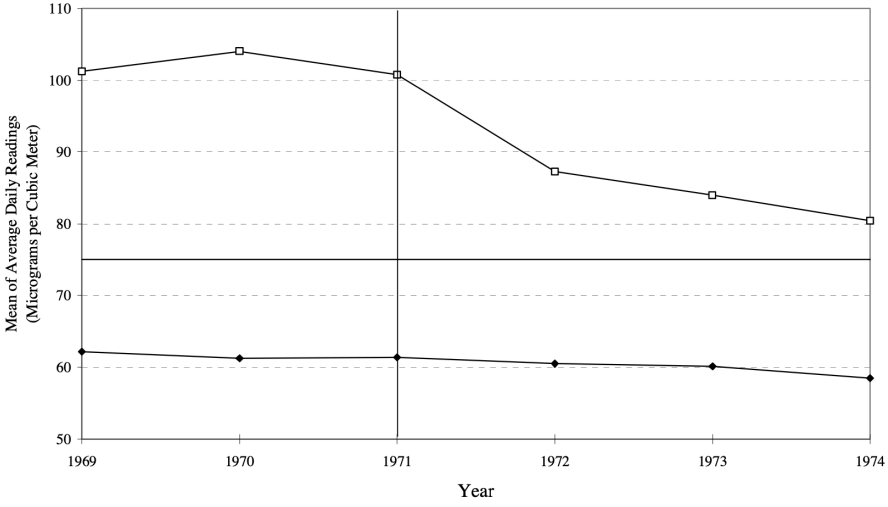
Areas with more particulates than threshold required to clean up air [called "non-attainment" areas = treatment group].

Areas with less particulates than threshold are control group [were not required to clean up].

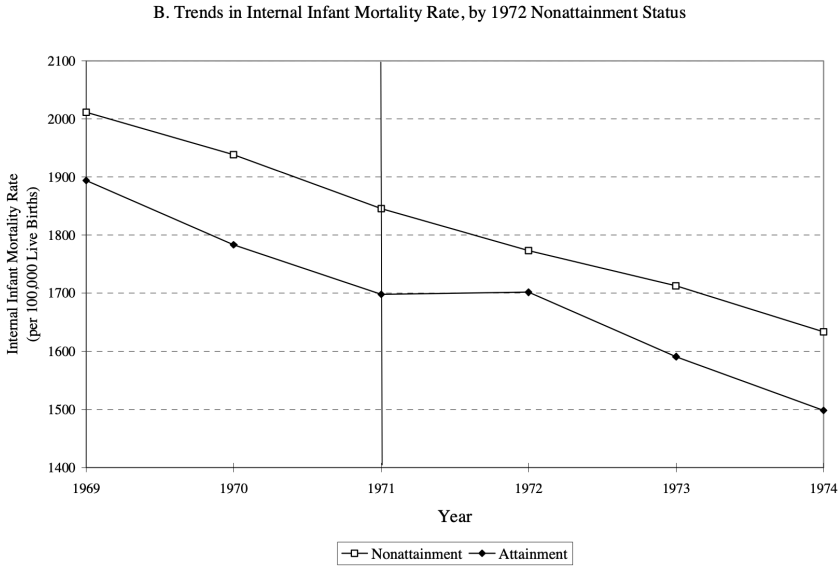
Compares infant mortality across 2 types of places before and after (DD approach)

Trends in TSPs Pollution and Infant Mortality, by 1972 Nonattainment Status

A. Trends in Mean TSPs Concentrations, by 1972 Nonattainment Status



Trends in Internal Infant Mortality Rate, by 1972 Nonattainment Status



Climate Change and CO_2 Emissions

Industrialization has dramatically increased CO2 emissions and atmospheric CO2 generates global warming

Four factors make this challenging (Wagner-Weitzman 2015):

1. **Global**: Emissions in one country affect the full world
2. **Irreversible**: Atmospheric CO2 has long life (centuries) [absent carbon capture tech breakthrough]
3. **Long-term**: Costs of global warming are decades/centuries away [how should this be discounted?]
4. **Uncertain**: Great uncertainty in costs of global warming [mitigation vs. amplifying feedback loops]

How fast should we start reducing emissions? [Stern-Weitzman want a fast reduction, Nordhaus advocates a slower path]

Main costs of Global Warming

Enormous variation across geographical areas and economic development. Pace of change makes adaptation daunting

1. Sea rise will flood low lying coasts and major population centers in many countries (e.g., Miami, Florida; value of real estate subject to regular flooding has dropped)
2. Impact on bio-diversity (mass extinctions)
3. Agricultural production could be disrupted by climate change and the increased weather variability it generates:

   demand for food is very inelastic in the short-run $\Rightarrow$ Spikes in prices if agricultural output falls $\Rightarrow$ disruption/famines possible in low income countries
4. Droughts and heat waves will make many places less livable Some societies may collapse and generate mass migration movements

Empirical Example: Costs of Global Warming

Estimating costs of Global warming is daunting because society will adapt and reduce costs (relative to a scenario with no adaptation)

Example: heat waves and mortality analysis of Barreca et al. (2016)

1. The mortality effect of an extremely hot day (80° F+) declined by about 75% between 1900-1959 and 1960-2004.
2. Adoption of residential air conditioning (AC) explains the entire decline
3. Worldwide adoption of AC will speed up the rate of climate change (if fossil fuel powered)

If we view global warming as a classical externality, it poses challenges because it is such a long-run problem.

CO_2 emissions impose a global warming externality $\Rightarrow$ Solution is to impose a carbon tax equal to the marginal damage of CO_2 emissions and let market forces work their magic

But what is the marginal damage of CO_2? It depends greatly on how you discount the future

Economists use interest rate r to discount future: \$1 today is worth $\$(1+r)T$ in T years (long-distance future heavily discounted: e.g., $r = 4\%$ and $T = 1000 \Rightarrow (1+r)T = 1017$)

If interest rate is high, it is desirable to let global warming happen and societies collapse!

Global Warming: Broader View

Massive CO_2 emissions pose existential civilizational risk (like CFC destroying vital ozone layer)

Only solution is to decarbonize and we need to do it fast (within decades not centuries)

Decarbonization is within sight: renewable electricity (solar/wind) + grid + big batteries could power most energy needs and replace most fossil fuels

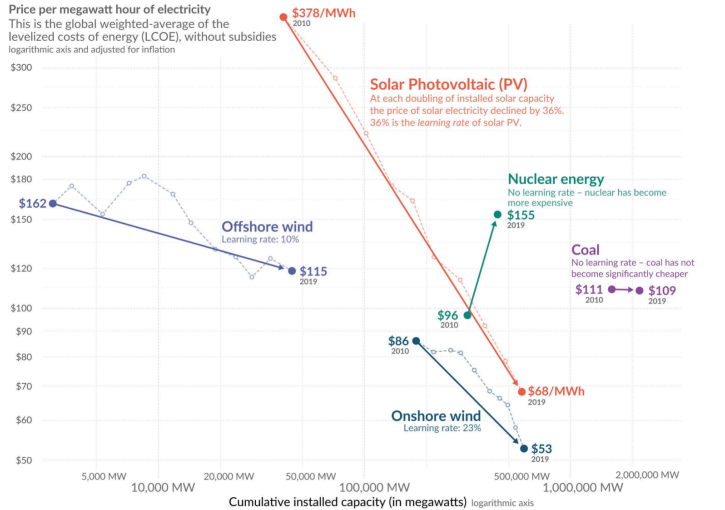
$\Rightarrow$ could it be done without killing economic growth and without huge short-term disruptions?

Economists' useful point: some sectors are easier to decarbonize than others (e.g. cars easier than planes)

$\Rightarrow$ start decarbonizing easiest sectors first (Sachs 2020)

Electricity from renewables became cheaper as we increased capacity – electricity from nuclear and coal did not

Our World in Data



Source: IRENA 2020 for all data on renewable sources; Lazard for the price of electricity from nuclear and coal – IAEA for nuclear capacity and Global Energy Monitor for coal capacity. Gas is not shown because the price between gas peaker and combined cycles differs signficantly, and global data on the capacity of each of these sources is not available. The price of electricity from gas has fallen over this decade, but over the longer run it is not following a learning curve.

OurWorldinData.org – Research and data to make progress against the world's largest problems.

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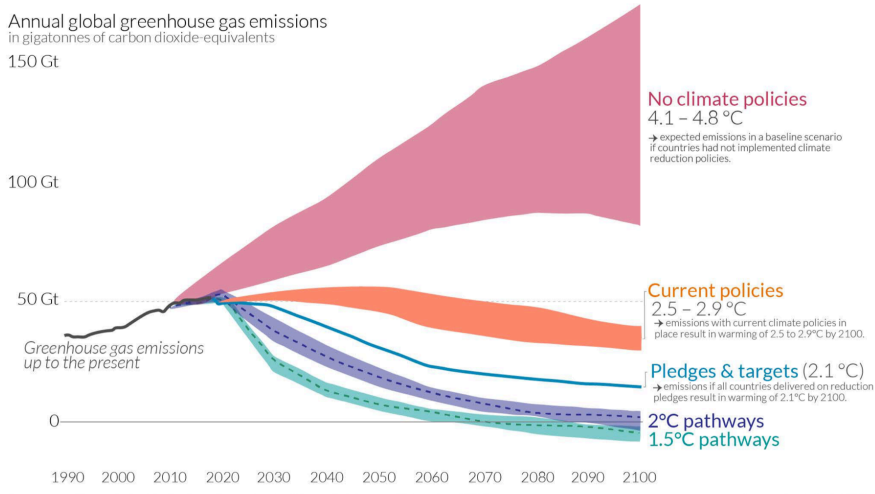
Global greenhouse gas emissions and warming scenarios

– Each pathway comes with uncertainty, marked by the shading from low to high emissions under each scenario.
– Warming refers to the expected global temperature rise by 2100, relative to pre-industrial temperatures.

Our World in Data



Data source: Climate Action Tracker (based on national policies and pledges as of November 2021).
OurWorldinData.org – Research and data to make progress against the world's largest problems.

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From one country perspective, decarbonizing is costly and benefit is modest (as global emissions is what matters)

Economists: countries need to make a coordinated binding agreement to decarbonize together

Kyoto 1997: 35 industrialized nations (but not US) agreed to reduce their emissions of greenhouse gases to 1990 levels by 2012 [with ability to trade emission rights among themselves]

Since then, series of international (but non-binding) pledges

However, a leader country can have dramatic impact:

$\Rightarrow$ Makes sense to provide successful local examples of decarbonization (such as California with its 100% renewable electricity mandate by 2045)

$\Rightarrow$ Big countries want to develop and control future renewable tech (race US vs. China is good in speeding transition)

How to Decarbonize? Richer Countries

Must become a clear policy choice that mobilizes society Encourage research on renewable technologies both public and private (King, David et al. 2015)

Plan phase out of carbon in various sectors [industrial policy] and weaken fossil fuel industry political power (Sachs 2020)

Raising carbon tax could be one tool (but we should not bet everything on it as it is regressive and unpopular)

Be flexible and compensate low income losers (to avoid yellow vests protests as in France with higher gas tax)

In the US, modest Obama moves, undone by Trump

Democrats offer **Green New Deal** (economic planning and industrial policy ideas coupled with social justice vision)

Biden administration passed Inflation-Reduction-Act in 2022

How to Decarbonize? Developing Countries

Disagreement between rich and developing countries on who should bear the cost of curbing greenhouse gas emissions

Rich countries responsible for most of historical CO_2 emissions

Poor countries want to develop using the cheapest available technologies (coal power still cheaper than renewables)

Makes sense for richer countries to encourage/help poorer countries leapfrog carbon in favor of renewable energy

Carrot: R&D on renewables in rich countries can be adopted in poorer countries, direct subsidies can help

Stick: Impose tariffs on carbon content of imported goods

How can we guarantee an emissions trajectory in line with the carbon budget?

- With a yearly cap on global emissions (or a global carbon price)

How to allocate carbon pricing revenues?

- An equal cash transfer for all human adults
- This “global basic income” of $30-50/month would alleviate extreme poverty

Douenne, Fabre, and Mattauch (2023) find majority support in 20 countries

Understanding Attitudes toward Climate Policies

Fighting Climate Change: International Attitudes toward Climate Policies

Antoine Dechezleprêtre, Adrien Fabre, Tobias Kruse, Bluebery Planterose, Ana Sanchez-Chico, and Stefanie Stantcheva

SOCIAL ECONOMICS LAB

OECD
BETTER POLICIES FOR BETTER LIVES

Motivation: Understanding international attitudes toward climate change and climate policies

Climate change is a pressing yet unresolved issue

To limit avg. temperature increase to <2°C above pre-industrial levels, must drastically reduce global emissions by 2050

Over 140 countries, representing 90% of global GHG emissions, have adopted or announced climate neutrality targets by mid-century

Given current policies, expect avg. temp rise of about 2.7°C by 2100

What drives support for or opposition to important climate policies across the world?

Lack of knowledge?

Effects on own budget and lifestyle?

Broader concerns about the impact on others and the economy?

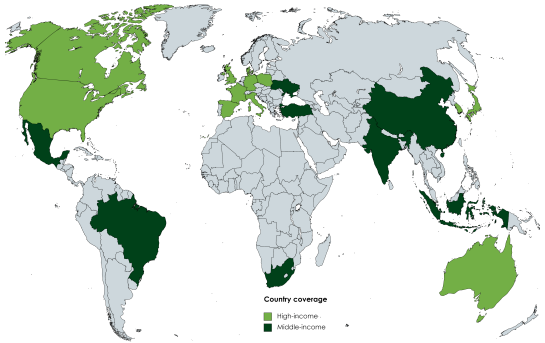
Struggle to assess how a given policy affects climate change?

Address these questions using surveys and experiments.

An international survey

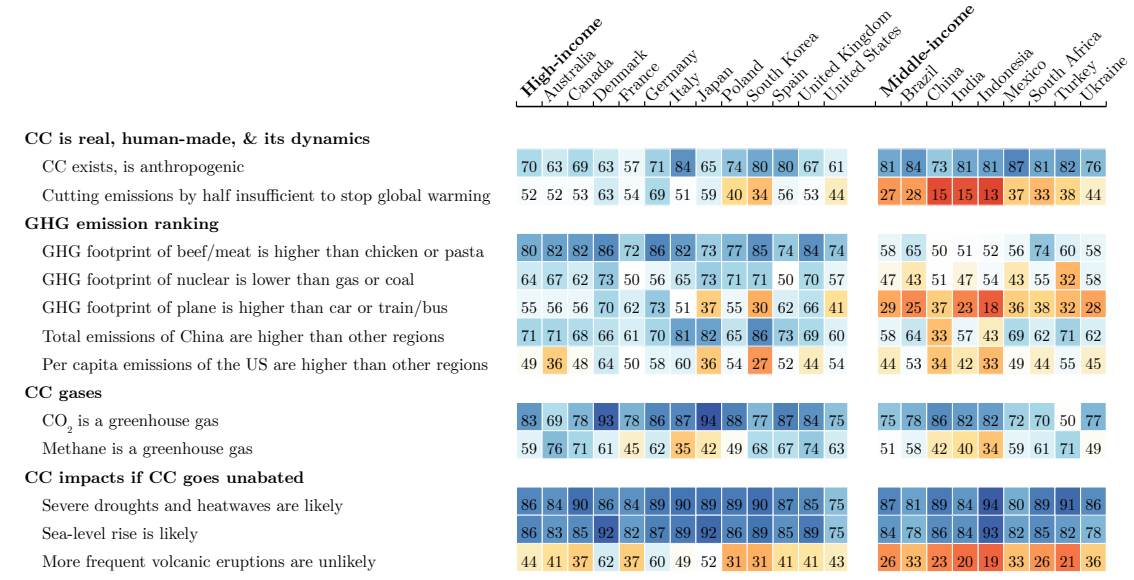
Large-scale, cross-country survey with +40,000 respondents to analyze attitudes on climate change and climate policies with wide country coverage:

20 countries in all world regions, middle-income as well as high-income countries, covering 72% of global CO_2 emissions, including 18 out of the 21 largest emitters. [1]

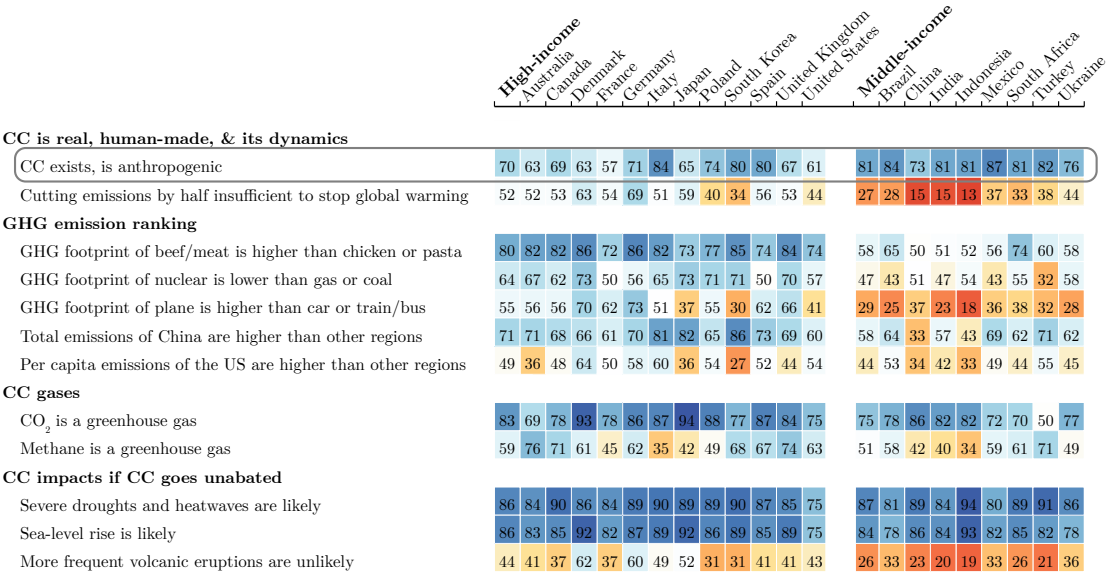


[1] The three missing countries are Russia, Iran, and Saudi Arabia.

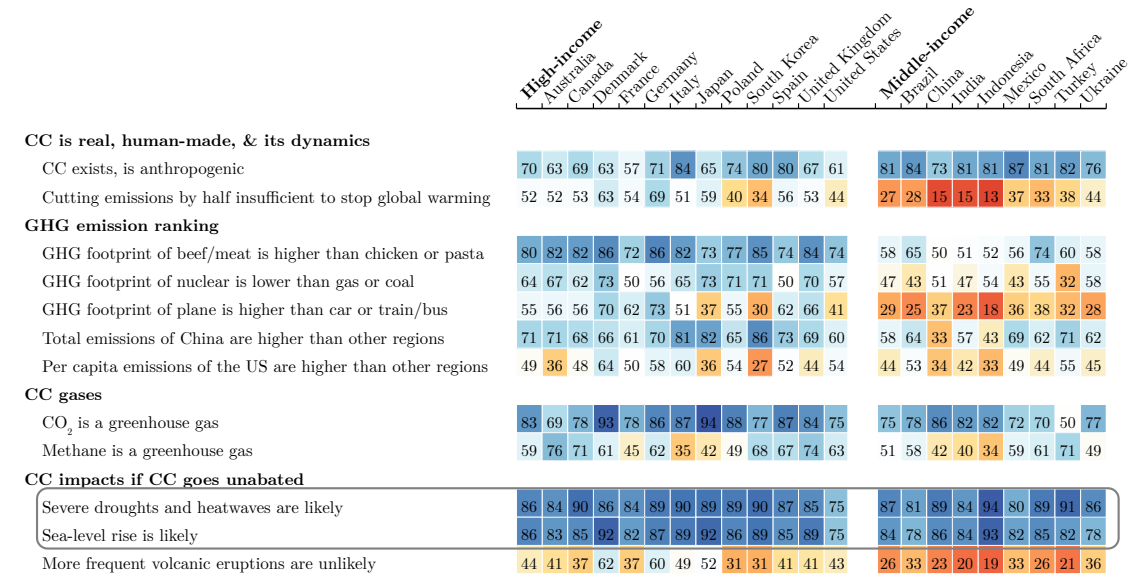
Knowledge across countries: Share of correct answers



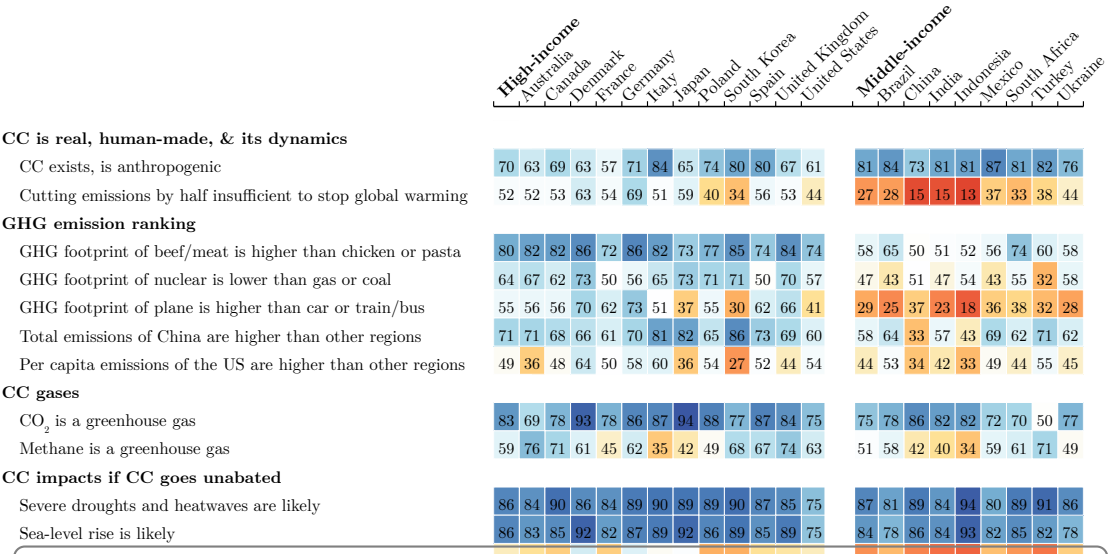
Few outright deny of climate change; most believe it is anthropogenic



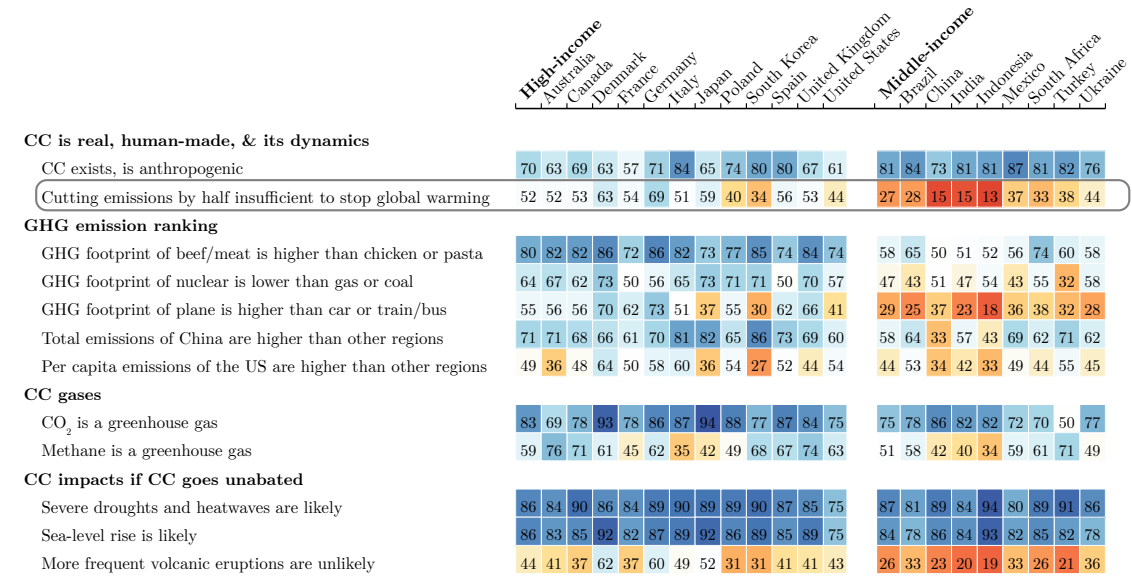
People correctly foresee consequences of climate change



People make insufficient distinction between disaster types



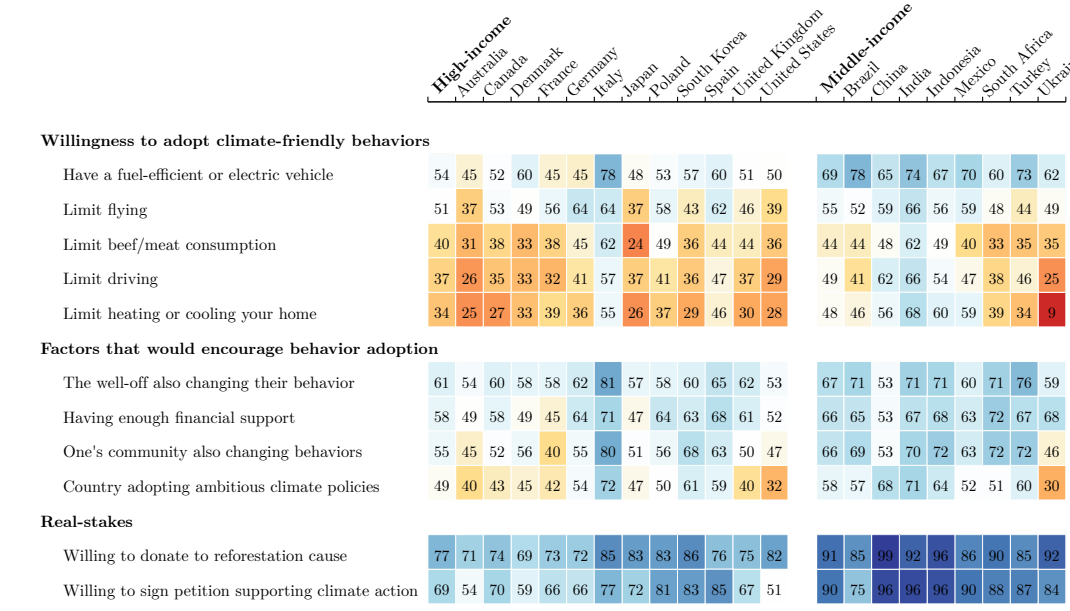
People are too optimistic about level of decarbonization needed



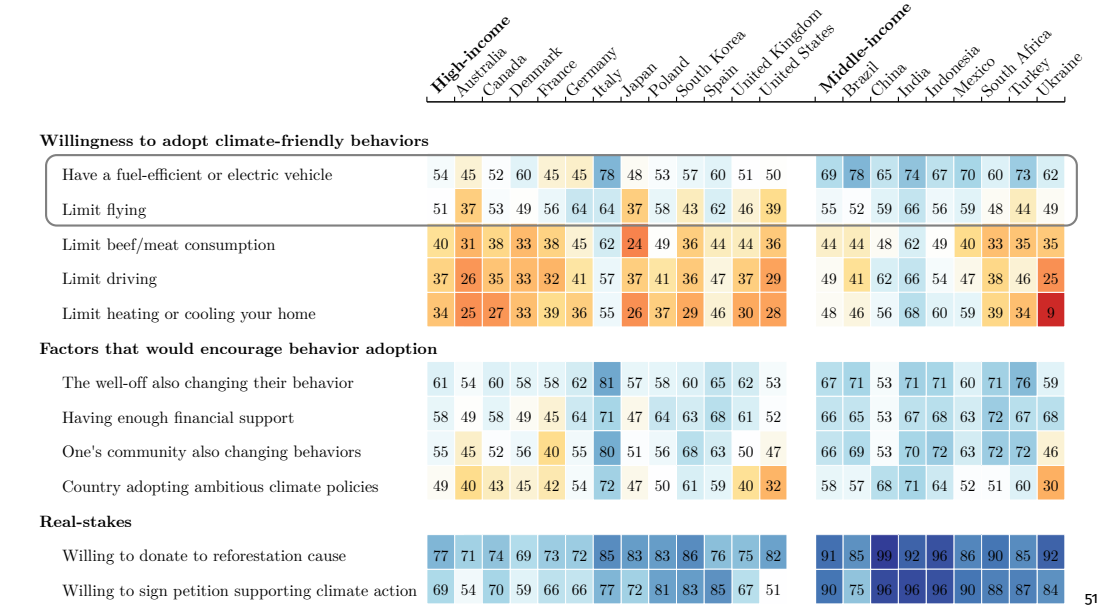
Most people are aware of the factors that cause climate change

	High-income												**Middle-income**									
	Australia	Canada	Denmark	France	Germany	Italy	Japan	Poland	South Korea	Spain	United Kingdom	United States	Brazil	China	India	Indonesia	Mexico	South Africa	Turkey	Ukraine
CC is real, human-made, & its dynamics																				
CC exists, is anthropogenic	70	63	69	63	57	71	84	65	74	80	80	67	61	81	84	73	81	81	87	81	82	76
Cutting emissions by half insufficient to stop global warming	52	52	53	63	54	69	51	59	40	34	56	53	44	27	28	15	15	13	37	33	38	44
GHG emission ranking																				
GHG footprint of beef/meat is higher than chicken or pasta	80	82	82	86	72	86	82	73	77	85	74	84	74	58	65	50	51	52	56	74	60	58
GHG footprint of nuclear is lower than gas or coal	64	67	62	73	50	56	65	73	71	71	50	70	57	47	43	51	47	54	43	55	32	58
GHG footprint of plane is higher than car or train/bus	55	56	56	70	62	73	51	37	55	30	62	66	41	29	25	37	23	18	36	38	32	28
Total emissions of China are higher than other regions	71	71	68	66	61	70	81	82	65	86	73	69	60	58	64	33	57	43	69	62	71	62
Per capita emissions of the US are higher than other regions	49	36	48	64	50	58	60	36	54	27	52	44	54	44	53	34	42	33	49	44	55	45
CC gases																				
CO_2 is a greenhouse gas	83	69	78	93	78	86	87	94	88	77	87	84	75	75	78	86	82	82	72	70	50	77
Methane is a greenhouse gas	59	76	71	61	45	62	35	42	49	68	67	74	63	51	58	42	40	34	59	61	71	49
CC impacts if CC goes unabated																				
Severe droughts and heatwaves are likely	86	84	90	86	84	89	90	89	89	90	87	85	75	87	81	89	84	94	80	89	91	86
Sea-level rise is likely	86	83	85	92	82	87	89	92	86	89	85	89	75	84	78	86	84	93	82	85	82	78
More frequent volcanic eruptions are unlikely	44	41	37	62	37	60	49	52	31	31	41	41	43	26	33	23	20	19	33	26	21	36

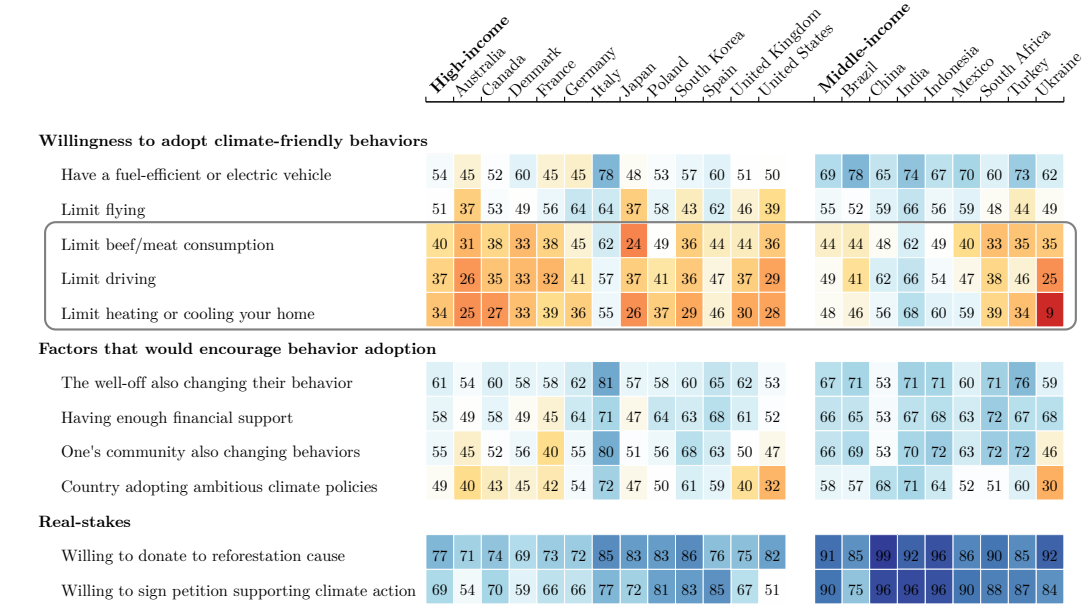
Share of people willing to adopt climate-friendly behaviors



Around half are willing to buy fuel-efficient car or to limit flying



People are unwilling to limit some behaviors



People are willing to change behavior with financial support and if others do

	High-income	Australia	Canada	Denmark	France	Germany	Italy	Japan	Poland	South Korea	Spain	United Kingdom	United States	**Middle-income**	Brazil	China	India	Indonesia	Mexico	South Africa	Turkey	Ukraine
Willingness to adopt climate-friendly behaviors																						
Have a fuel-efficient or electric vehicle	54	45	52	60	45	45	78	48	53	57	60	51	50	69	78	65	74	67	70	60	73	62
Limit flying	51	37	53	49	56	64	64	37	58	43	62	46	39	55	52	59	66	56	59	48	44	49
Limit beef/meat consumption	40	31	38	33	38	45	62	24	49	36	44	44	36	44	44	48	62	49	40	33	35	35
Limit driving	37	26	35	33	32	41	57	37	41	36	47	37	29	49	41	62	66	54	47	38	46	25
Limit heating or cooling your home	34	25	27	33	39	36	55	26	37	29	46	30	28	48	46	56	68	60	59	39	34	9
Factors that would encourage behavior adoption																						
The well-off also changing their behavior	61	54	60	58	58	62	81	57	58	60	65	62	53	67	71	53	71	71	60	71	76	59
Having enough financial support	58	49	58	49	45	64	71	47	64	63	68	61	52	66	65	53	67	68	63	72	67	68
One's community also changing behaviors	55	45	52	56	40	55	80	51	56	68	63	50	47	66	69	53	70	72	63	72	72	46
Country adopting ambitious climate policies	49	40	43	45	42	54	72	47	50	61	59	40	32	58	57	68	71	64	52	51	60	30
Real-stakes																						
Willing to donate to reforestation cause	77	71	74	69	73	72	85	83	83	86	76	75	82	91	85	99	92	96	86	90	85	92
Willing to sign petition supporting climate action	69	54	70	59	66	66	77	72	81	83	85	67	51	90	75	96	96	96	90	88	87	84

Who support more climate action?

Political leanings very strong predictors (left-leaning respondents support more climate action).

Those with higher levels of education, particularly college degree (even conditional on income).

Those whose lifestyle allows them to do so: i) have access to high-quality public transportation; ii) rely less on a car; iii) have lower gas expenses.

What explains support for climate action?

1. Effectiveness belief: the policy is helpful in reducing emissions.
2. Inequality concern: the policy will not disproportionately hurt lower-income or vulnerable households.
3. Self-interest: the policy will not financially hurt my household.

Share of respondents who support climate change policies

Main Policies Studied																				
Green infrastructure program	57	49	56	53	57	42	78	48	58	68	71	54	50	78	77	82	80	80	84	73	76	69
Ban on combustion-engine cars	43	35	47	41	28	32	54	41	44	52	54	45	39	65	60	72	77	65	67	53	62	58
Carbon tax with cash transfers	37	34	41	30	29	28	47	35	36	53	44	34	33	59	47	80	71	67	55	52	55	39
Transportation Policies																				
Ban on polluting cars in city centers	60	53	60	66	57	50	76	64	61	52	64	65	49	71	65	73	74	85	72	66	60	67
Ban on combustion-engine vehicles w. alternatives available	48	38	47	42	42	41	58	51	48	58	57	52	44	68	60	78	77	72	66	62	64	63
Tax on flying (+20%)	45	35	44	60	46	53	41	47	44	42	44	46	33	52	39	61	64	68	51	43	45	36
Energy Policies																				
Subsidies to low-carbon technologies	67	62	65	67	56	64	79	69	75	71	73	65	57	73	77	75	68	79	66	75	75	68
Mandatory and subsidized insulation of buildings	66	70	64	70	64	60	73	59	72	72	71	70	53	75		80				73	75	75
Funding clean energy in low-income countries	54	49	50	53	48	48	76	53	55	57	65	51	50	73	63	71	75	81	74	76	66	78
Tax on fossil fuels ($45/tCO2)	36	36	40	43	31	31	38	35	27	42	39	38	34	48	35	58	64	58	41	38	52	28
Food Policies																				
Subsidies on organic and local vegetables	56	42	50	59	52	56	71	46	73	62	65	49	43	68	62	79		77	58	59	80	58
Ban of intensive cattle farming	42	32	41	31	55	49	64	17	44	44	43	50	36	39	38	50		45	46	28	32	25
Removal of subsidies for cattle farming	34	31	33	32	28	38	42	16	34	31	42	37	38	39	43	47		51	47	27	31	22
A high tax on cattle products, doubling beef prices	30	24	27	31	29	40	37	19	30	26	31	31	31	36	33	48		49	37	30	26	24
Support for Carbon Tax With:																				
Funding environmental infrastructures	63	60	48	60	65	60	76	56	68	78	69	63	56	75	78	76	71	81	73	79	73	69
Subsidies to low-carbon tech.	63	58	49	52	57	66	76	68	71	79	69	59	53	73	74	79	68	79	71	78	66	65
Reduction in personal income taxes	57	52	48	38	62	54	72	64	69	62	67	52	49	69	69	74	68	74	69	68	66	64
Cash transfers to the poorest households	53	51	48	41	55	47	68	54	50	59	63	57	46	73	67	82	69	86	66	65	82	62
Cash transfers to constrained households	50	50	42	36	55	47	62	47	39	62	61	52	44	64	59	69	63	74	59	60	65	61
Tax rebates for the most affected firms	48	41	41	38	52	34	66	49	61	59	55	41	43	62	59	72	65	68	54	63	55	56
Reduction in the public deficit	48	40	39	34	49	39	66	50	56	48	62	44	48	63	62	72	65	70	61	62	57	52
Progressive transfers	47	40	54			45	66	56	40	44	40	43		58	64	84	67	61	44	45	51	49
Equal cash transfers to all households	38	37	38	27	45	31	42	43	37	42	44	33	38	61	45	70	64	76	62	57	59	53
Reduction in corporate income taxes	37	29	32	24	37	25	55	38	48	48	50	26	29	58	54	67	60	67	61	50	60	42

More than half support subsidies to low-carbon technology and infrastructure

	High-income												**Middle-income**									
	Australia	Canada	Denmark	France	Germany	Italy	Japan	Poland	South Korea	Spain	United Kingdom	United States	Brazil	China	India	Indonesia	Mexico	South Africa	Turkey	Ukraine
Main Policies Studied																				
Green infrastructure program	57	49	56	53	57	42	78	48	58	68	71	54	50	78	77	82	80	80	84	73	76	69
Ban on combustion-engine cars	43	35	47	41	28	32	54	41	44	52	54	45	39	65	60	72	77	65	67	53	62	58
Carbon tax with cash transfers	37	34	41	30	29	28	47	35	36	53	44	34	33	59	47	80	71	67	55	52	55	39
Transportation Policies																						
Ban on polluting cars in city centers	60	53	60	66	57	50	76	64	61	52	64	65	49	71	65	73	74	85	72	66	60	67
Ban on combustion-engine vehicles w. alternatives available	48	38	47	42	42	41	58	51	48	58	57	52	44	68	60	78	77	72	66	62	64	63
Tax on flying (+20%)	45	35	44	60	46	53	41	47	44	42	44	46	33	52	39	61	64	68	51	43	45	36
Energy Policies																						
Subsidies to low-carbon technologies	67	62	65	67	56	64	79	69	75	71	73	65	57	73	77	75	68	79	66	75	75	68
Mandatory and subsidized insulation of buildings	66	70	64	70	64	60	73	59	72	72	71	70	53	75		80				73	75	75
Funding clean energy in low-income countries	54	49	50	53	48	48	76	53	55	57	65	51	50	73	63	71	75	81	74	76	66	78
Tax on fossil fuels ($45/tCO2)	36	36	40	43	31	31	38	35	27	42	39	38	34	48	35	58	64	58	41	38	52	28
Food Policies																						
Subsidies on organic and local vegetables	56	42	50	59	52	56	71	46	73	62	65	49	43	68	62	79		77	58	59	80	58
Ban of intensive cattle farming	42	32	41	31	55	49	64	17	44	44	43	50	36	39	38	50		45	46	28	32	25
Removal of subsidies for cattle farming	34	31	33	32	28	38	42	16	34	31	42	37	38	39	43	47		51	47	27	31	22
A high tax on cattle products, doubling beef prices	30	24	27	31	29	40	37	19	30	26	31	31	31	36	33	48		49	37	30	26	24
Support for Carbon Tax With:																						
Funding environmental infrastructures	63	60	48	60	65	60	76	56	68	78	69	63	56	75	78	76	71	81	73	79	73	69
Subsidies to low-carbon tech.	63	58	49	52	57	66	76	68	71	79	69	59	53	73	74	79	68	79	71	78	66	65
Reduction in personal income taxes	57	52	48	38	62	54	72	64	69	62	67	52	49	69	69	74	68	74	69	68	66	64
Cash transfers to the poorest households	53	51	48	41	55	47	68	54	50	59	63	57	46	73	67	82	69	86	66	65	82	62
Cash transfers to constrained households	50	50	42	36	55	47	62	47	39	62	61	52	44	64	59	69	63	74	59	60	65	61
Tax rebates for the most affected firms	48	41	41	38	52	34	66	49	61	59	55	41	43	62	59	72	65	68	54	63	55	56
Reduction in the public deficit	48	40	39	34	49	39	66	50	56	48	62	44	48	63	62	72	65	70	61	62	57	52
Progressive transfers	47	40	54			45	66	56	40	44	40	43		58	64	84	67	61	44	45	51	49
Equal cash transfers to all households	38	37	38	27	45	31	42	43	37	42	44	33	38	61	45	70	64	76	62	57	59	53
Reduction in corporate income taxes	37	29	32	24	37	25	55	38	48	48	50	26	29	58	54	67	60	67	61	50	60	42

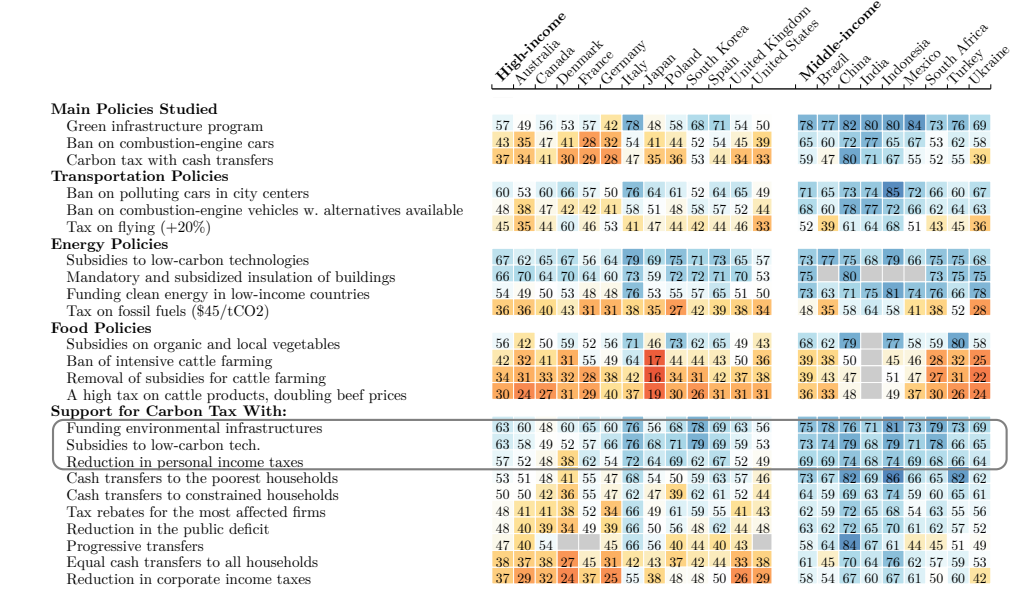
Many support banning polluting vehicles in city centers

	High-income												**Middle-income**									
	Australia	Canada	Denmark	France	Germany	Italy	Japan	Poland	South Korea	Spain	United Kingdom	United States	Brazil	China	India	Indonesia	Mexico	South Africa	Turkey	Ukraine
Main Policies Studied																				
Green infrastructure program	57	49	56	53	57	42	78	48	58	68	71	54	50	78	77	82	80	80	84	73	76	69
Ban on combustion-engine cars	43	35	47	41	28	32	54	41	44	52	54	45	39	65	60	72	77	65	67	53	62	58
Carbon tax with cash transfers	37	34	41	30	29	28	47	35	36	53	44	34	33	59	47	80	71	67	55	52	55	39
Transportation Policies																						
Ban on polluting cars in city centers	60	53	60	66	57	50	76	64	61	52	64	65	49	71	65	73	74	85	72	66	60	67
Ban on combustion-engine vehicles w. alternatives available	48	38	47	42	42	41	58	51	48	58	57	52	44	68	60	78	77	72	66	62	64	63
Tax on flying (+20%)	45	35	44	60	46	53	41	47	44	42	44	46	33	52	39	61	64	68	51	43	45	36
Energy Policies																						
Subsidies to low-carbon technologies	67	62	65	67	56	64	79	69	75	71	73	65	57	73	77	75	68	79	66	75	75	68
Mandatory and subsidized insulation of buildings	66	70	64	70	64	60	73	59	72	72	71	70	53	75		80				73	75	75
Funding clean energy in low-income countries	54	49	50	53	48	48	76	53	55	57	65	51	50	73	63	71	75	81	74	76	66	78
Tax on fossil fuels ($45/tCO2)	36	36	40	43	31	31	38	35	27	42	39	38	34	48	35	58	64	58	41	38	52	28
Food Policies																						
Subsidies on organic and local vegetables	56	42	50	59	52	56	71	46	73	62	65	49	43	68	62	79		77	58	59	80	58
Ban of intensive cattle farming	42	32	41	31	55	49	64	17	44	44	43	50	36	39	38	50		45	46	28	32	25
Removal of subsidies for cattle farming	34	31	33	32	28	38	42	16	34	31	42	37	38	39	43	47		51	47	27	31	22
A high tax on cattle products, doubling beef prices	30	24	27	31	29	40	37	19	30	26	31	31	31	36	33	48		49	37	30	26	24
Support for Carbon Tax With:																						
Funding environmental infrastructures	63	60	48	60	65	60	76	56	68	78	69	63	56	75	78	76	71	81	73	79	73	69
Subsidies to low-carbon tech.	63	58	49	52	57	66	76	68	71	79	69	59	53	73	74	79	68	79	71	78	66	65
Reduction in personal income taxes	57	52	48	38	62	54	72	64	69	62	67	52	49	69	69	74	68	74	69	68	66	64
Cash transfers to the poorest households	53	51	48	41	55	47	68	54	50	59	63	57	46	73	67	82	69	86	66	65	82	62
Cash transfers to constrained households	50	50	42	36	55	47	62	47	39	62	61	52	44	64	59	69	63	74	59	60	65	61
Tax rebates for the most affected firms	48	41	41	38	52	34	66	49	61	59	55	41	43	62	59	72	65	68	54	63	55	56
Reduction in the public deficit	48	40	39	34	49	39	66	50	56	48	62	44	48	63	62	72	65	70	61	62	57	52
Progressive transfers	47	40	54			45	66	56	40	44	40	43		58	64	84	67	61	44	45	51	49
Equal cash transfers to all households	38	37	38	27	45	31	42	43	37	42	44	33	38	61	45	70	64	76	62	57	59	53
Reduction in corporate income taxes	37	29	32	24	37	25	55	38	48	48	50	26	29	58	54	67	60	67	61	50	60	42

Carbon taxes appear to be least popular at first glance

	High-income												**Middle-income**											
	Australia	Canada	Denmark	France	Germany	Italy	Japan	Poland	South Korea	Spain	United Kingdom	United States	Brazil	China	India	Indonesia	Mexico	South Africa	Turkey	Ukraine				
Main Policies Studied																								
Green infrastructure program	57	49	56	53	57	42	78	48	58	68	71	54	50	78	77	82	80	80	84	73	76	69		
Ban on combustion-engine cars	43	35	47	41	28	32	54	41	44	52	54	45	39	65	60	72	77	65	67	53	62	58		
Carbon tax with cash transfers	37	34	41	30	29	28	47	35	36	53	44	34	33	59	47	80	71	67	55	52	55	39		
Transportation Policies																								
Ban on polluting cars in city centers	60	53	60	66	57	50	76	64	61	52	64	65	49	71	65	73	74	85	72	66	60	67		
Ban on combustion-engine vehicles w. alternatives available	48	38	47	42	42	41	58	51	48	58	57	52	44	68	60	78	77	72	66	62	64	63		
Tax on flying (+20%)	45	35	44	60	46	53	41	47	44	42	44	46	33	52	39	61	64	68	51	43	45	36		
Energy Policies																								
Subsidies to low-carbon technologies	67	62	65	67	56	64	79	69	75	71	73	65	57	73	77	75	68	79	66	75	75	68		
Mandatory and subsidized insulation of buildings	66	70	64	70	64	60	73	59	72	72	71	70	53	75		80				73	75	75		
Funding clean energy in low-income countries	54	49	50	53	48	48	76	53	55	57	65	51	50	73	63	71	75	81	74	76	66	78		
Tax on fossil fuels ($45/tCO2)	36	36	40	43	31	31	38	35	27	42	39	38	34	48	35	58	64	58	41	38	52	28		
Food Policies																								
Subsidies on organic and local vegetables	56	42	50	59	52	56	71	46	73	62	65	49	43	68	62	79		77	58	59	80	58		
Ban of intensive cattle farming	42	32	41	31	55	49	64	17	44	44	43	50	36	39	38	50		45	46	28	32	25		
Removal of subsidies for cattle farming	34	31	33	32	28	38	42	16	34	31	42	37	38	39	43	47		51	47	27	31	22		
A high tax on cattle products, doubling beef prices	30	24	27	31	29	40	37	19	30	26	31	31	31	36	33	48		49	37	30	26	24		
Support for Carbon Tax With:																								
Funding environmental infrastructures	63	60	48	60	65	60	76	56	68	78	69	63	56	75	78	76	71	81	73	79	73	69		
Subsidies to low-carbon tech.	63	58	49	52	57	66	76	68	71	79	69	59	53	73	74	79	68	79	71	78	66	65		
Reduction in personal income taxes	57	52	48	38	62	54	72	64	69	62	67	52	49	69	69	74	68	74	69	68	66	64		
Cash transfers to the poorest households	53	51	48	41	55	47	68	54	50	59	63	57	46	73	67	82	69	86	66	65	82	62		
Cash transfers to constrained households	50	50	42	36	55	47	62	47	39	62	61	52	44	64	59	69	63	74	59	60	65	61		
Tax rebates for the most affected firms	48	41	41	38	52	34	66	49	61	59	55	41	43	62	59	72	65	68	54	63	55	56		
Reduction in the public deficit	48	40	39	34	49	39	66	50	56	48	62	44	48	63	62	72	65	70	61	62	57	52		
Progressive transfers	47	40	54			45	66	56	40	44	40	43		58	64	84	67	61	44	45	51	49		
Equal cash transfers to all households	38	37	38	27	45	31	42	43	37	42	44	33	38	61	45	70	64	76	62	57	59	53		
Reduction in corporate income taxes	37	29	32	24	37	25	55	38	48	48	50	26	29	58	54	67	60	67	61	50	60	42		

Use of revenue matters substantially for support of carbon taxes



Least support for carbon tax with equal transfers or to reduce corporate tax

Main Policies Studied																				
Green infrastructure program	57	49	56	53	57	42	78	48	58	68	71	54	50	78	77	82	80	80	84	73	76	69
Ban on combustion-engine cars	43	35	47	41	28	32	54	41	44	52	54	45	39	65	60	72	77	65	67	53	62	58
Carbon tax with cash transfers	37	34	41	30	29	28	47	35	36	53	44	34	33	59	47	80	71	67	55	52	55	39
Transportation Policies																				
Ban on polluting cars in city centers	60	53	60	66	57	50	76	64	61	52	64	65	49	71	65	73	74	85	72	66	60	67
Ban on combustion-engine vehicles w. alternatives available	48	38	47	42	42	41	58	51	48	58	57	52	44	68	60	78	77	72	66	62	64	63
Tax on flying (+20%)	45	35	44	60	46	53	41	47	44	42	44	46	33	52	39	61	64	68	51	43	45	36
Energy Policies																				
Subsidies to low-carbon technologies	67	62	65	67	56	64	79	69	75	71	73	65	57	73	77	75	68	79	66	75	75	68
Mandatory and subsidized insulation of buildings	66	70	64	70	64	60	73	59	72	72	71	70	53	75		80				73	75	75
Funding clean energy in low-income countries	54	49	50	53	48	48	76	53	55	57	65	51	50	73	63	71	75	81	74	76	66	78
Tax on fossil fuels ($45/tCO2)	36	36	40	43	31	31	38	35	27	42	39	38	34	48	35	58	64	58	41	38	52	28
Food Policies																				
Subsidies on organic and local vegetables	56	42	50	59	52	56	71	46	73	62	65	49	43	68	62	79		77	58	59	80	58
Ban of intensive cattle farming	42	32	41	31	55	49	64	17	44	44	43	50	36	39	38	50		45	46	28	32	25
Removal of subsidies for cattle farming	34	31	33	32	28	38	42	16	34	31	42	37	38	39	43	47		51	47	27	31	22
A high tax on cattle products, doubling beef prices	30	24	27	31	29	40	37	19	30	26	31	31	31	36	33	48		49	37	30	26	24
Support for Carbon Tax With:																				
Funding environmental infrastructures	63	60	48	60	65	60	76	56	68	78	69	63	56	75	78	76	71	81	73	79	73	69
Subsidies to low-carbon tech.	63	58	49	52	57	66	76	68	71	79	69	59	53	73	74	79	68	79	71	78	66	65
Reduction in personal income taxes	57	52	48	38	62	54	72	64	69	62	67	52	49	69	69	74	68	74	69	68	66	64
Cash transfers to the poorest households	53	51	48	41	55	47	68	54	50	59	63	57	46	73	67	82	69	86	66	65	82	62
Cash transfers to constrained households	50	50	42	36	55	47	62	47	39	62	61	52	44	64	59	69	63	74	59	60	65	61
Tax rebates for the most affected firms	48	41	41	38	52	34	66	49	61	59	55	41	43	62	59	72	65	68	54	63	55	56
Reduction in the public deficit	48	40	39	34	49	39	66	50	56	48	62	44	48	63	62	72	65	70	61	62	57	52
Progressive transfers	47	40	54			45	66	56	40	44	40	43		58	64	84	67	61	44	45	51	49
Equal cash transfers to all households	38	37	38	27	45	31	42	43	37	42	44	33	38	61	45	70	64	76	62	57	59	53
Reduction in corporate income taxes	37	29	32	24	37	25	55	38	48	48	50	26	29	58	54	67	60	67	61	50	60	42

Policies to reduce cattle farming least popular in all countries

Main Policies Studied																				
Green infrastructure program	57	49	56	53	57	42	78	48	58	68	71	54	50	78	77	82	80	80	84	73	76	69
Ban on combustion-engine cars	43	35	47	41	28	32	54	41	44	52	54	45	39	65	60	72	77	65	67	53	62	58
Carbon tax with cash transfers	37	34	41	30	29	28	47	35	36	53	44	34	33	59	47	80	71	67	55	52	55	39
Transportation Policies																				
Ban on polluting cars in city centers	60	53	60	66	57	50	76	64	61	52	64	65	49	71	65	73	74	85	72	66	60	67
Ban on combustion-engine vehicles w. alternatives available	48	38	47	42	42	41	58	51	48	58	57	52	44	68	60	78	77	72	66	62	64	63
Tax on flying (+20%)	45	35	44	60	46	53	41	47	44	42	44	46	33	52	39	61	64	68	51	43	45	36
Energy Policies																				
Subsidies to low-carbon technologies	67	62	65	67	56	64	79	69	75	71	73	65	57	73	77	75	68	79	66	75	75	68
Mandatory and subsidized insulation of buildings	66	70	64	70	64	60	73	59	72	72	71	70	53	75		80			73	75	75	
Funding clean energy in low-income countries	54	49	50	53	48	48	76	53	55	57	65	51	50	73	63	71	75	81	74	76	66	78
Tax on fossil fuels ($45/tCO2)	36	36	40	43	31	31	38	35	27	42	39	38	34	48	35	58	64	58	41	38	52	28
Food Policies																				
Subsidies on organic and local vegetables	56	42	50	59	52	56	71	46	73	62	65	49	43	68	62	79		77	58	59	80	58
Ban of intensive cattle farming	42	32	41	31	55	49	64	17	44	44	43	50	36	39	38	50		45	46	28	32	25
Removal of subsidies for cattle farming	34	31	33	32	28	38	42	16	34	31	42	37	38	39	43	47		51	47	27	31	22
A high tax on cattle products, doubling beef prices	30	24	27	31	29	40	37	19	30	26	31	31	31	36	33	48		49	37	30	26	24
Support for Carbon Tax With:																				
Funding environmental infrastructures	63	60	48	60	65	60	76	56	68	78	69	63	56	75	78	76	71	81	73	79	73	69
Subsidies to low-carbon tech.	63	58	49	52	57	66	76	68	71	79	69	59	53	73	74	79	68	79	71	78	66	65
Reduction in personal income taxes	57	52	48	38	62	54	72	64	69	62	67	52	49	69	69	74	68	74	69	68	66	64
Cash transfers to the poorest households	53	51	48	41	55	47	68	54	50	59	63	57	46	73	67	82	69	86	66	65	82	62
Cash transfers to constrained households	50	50	42	36	55	47	62	47	39	62	61	52	44	64	59	69	63	74	59	60	65	61
Tax rebates for the most affected firms	48	41	41	38	52	34	66	49	61	59	55	41	43	62	59	72	65	68	54	63	55	56
Reduction in the public deficit	48	40	39	34	49	39	66	50	56	48	62	44	48	63	62	72	65	70	61	62	57	52
Progressive transfers	47	40	54			45	66	56	40	44	40	43		58	64	84	67	61	44	45	51	49
Equal cash transfers to all households	38	37	38	27	45	31	42	43	37	42	44	33	38	61	45	70	64	76	62	57	59	53
Reduction in corporate income taxes	37	29	32	24	37	25	55	38	48	48	50	26	29	58	54	67	60	67	61	50	60	42

Policy Implications

1. Policies need to be effective and distributionally progressive: compensate low-income and vulnerable households.

2. There is a need for explanations of policies' effectiveness and distributional impacts, not just information about climate change impacts

3. People care about impact on their households, so need to provide alternatives and means to substitute before imposing punitive policies.

Help households transition out of fossil fuel equipment (cars, heating systems). Requires time and financial help.

Ensure a transition (e.g.: announce path of carbon tax increases in advance, especially in light of current energy prices)

THANK YOU!

These slides are available on my website: https://bluebery-planterose.com/teaching

These slides are partly based on courses by: Ghazala Azmat, Raj Chetty, Emmanuel Saez, Stefanie Stantcheva, and Gabriel Zucman.