The distributional impacts of market-based climate policy

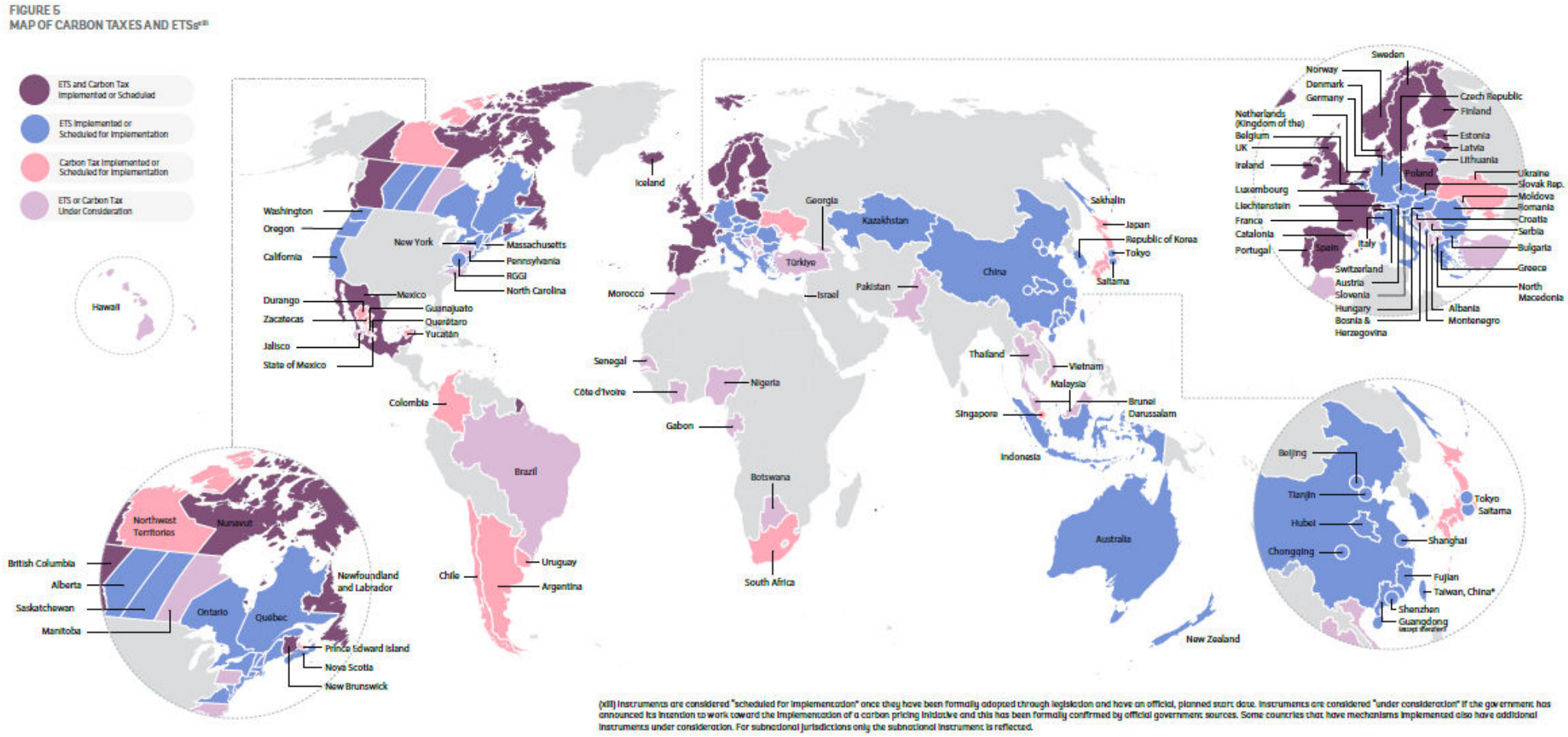
State of knowledge and future directions for research

International Conference on Ex-Post Evaluation of Emission Trading

Jan Christoph Steckel

June 20th, 2023

The state of carbon pricing



(xiii) Instruments are considered "scheduled for implementation" once they have been formally adopted through legislation and have an official, planned start date. Instruments are considered "under consideration" if the government has announced its intention to work toward the implementation of a carbon pricing initiative and this has been formally confirmed by official government sources. Some countries that have mechanisms implemented also have additional instruments under consideration. For subnational jurisdictions only the subnational instrument is reflected.

25% of global emissions now covered by carbon pricing, increasingly in LMICs.
Yet, prices are typically low.

Carbon pricing: Why, and why should we care about distributional effects?

Increasing amount of countries consider carbon pricing

- Effective in decreasing emissions where it has been applied thus far
- Can increase tax base
- Cover informal sector
- Generate revenues

France, 2018

Experiences with fossil fuel subsidy reforms and carbon pricing in the past

- Broad-based resistance, e.g. to rising energy prices
- Immediate price increases can lead to large protests that have the power to stop the reform
- Despite reform (partly) being progressive, i.e. pro-poor!


Indonesia, 2012

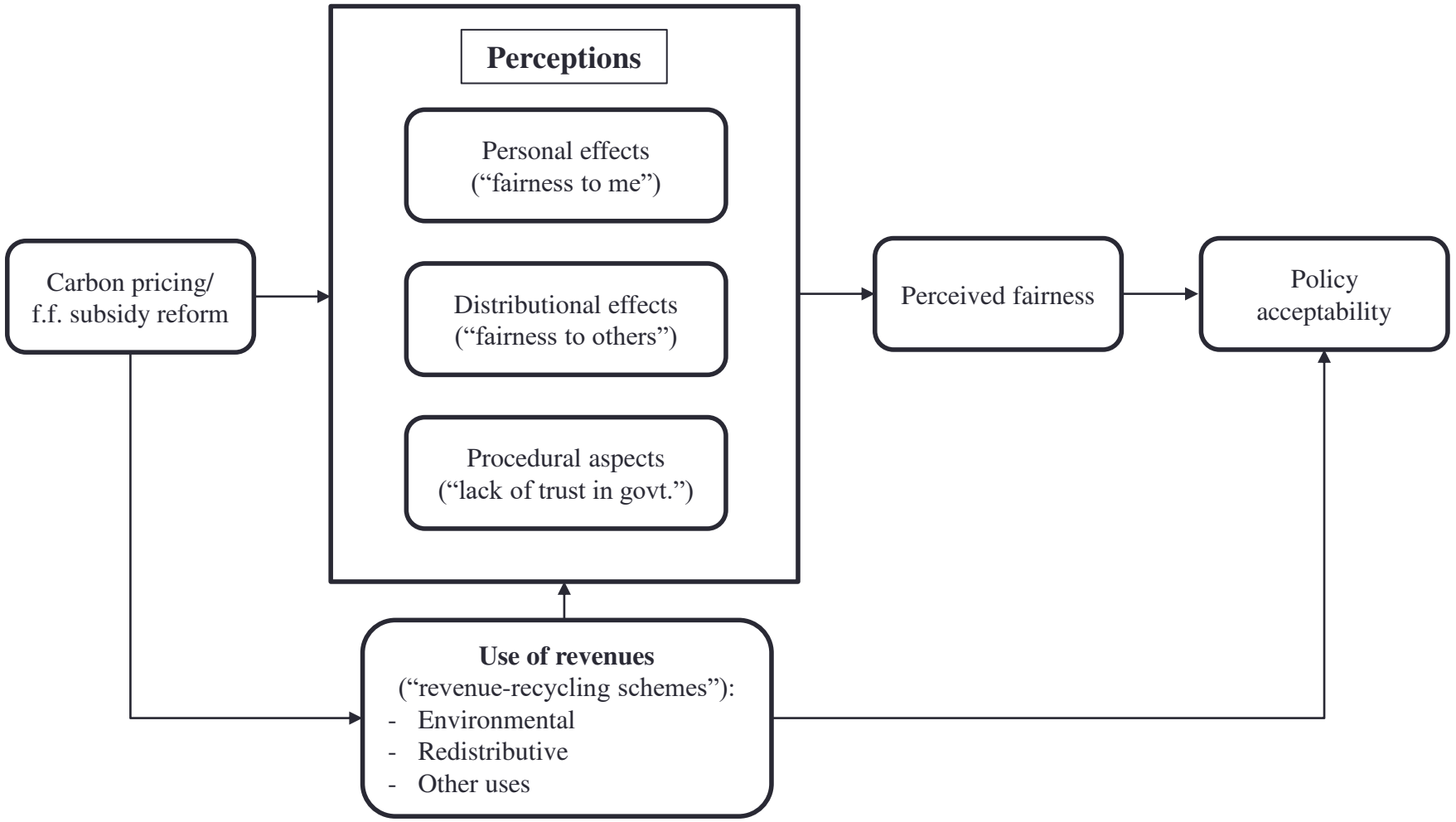
Ecuador, 2019

Not caring about distributional effects might make efficient policies politically unfeasible.

So, what do we know?

Nigeria, 2020

What determines policy acceptability?



Modified from Maestre-Andres et al. 2019

Three dimensions of distributional effects

Segment of Population	Criterion	Dimension of Distribution	Guiding questions
The Lower-Income Groups	Distributional effects	Vertical Distribution	What cost falls on the poorest members of society?

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*: Assumption: Additional costs matter to households and correlate with political support.

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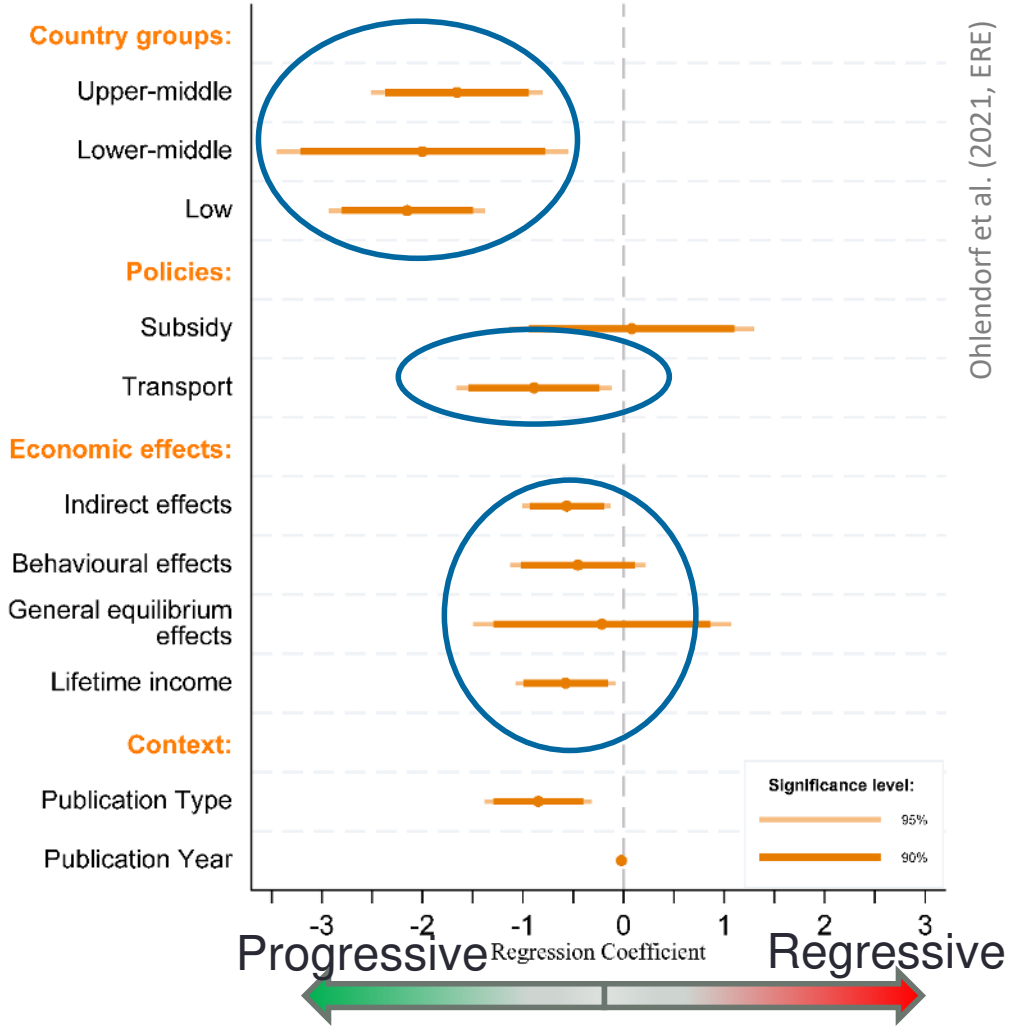
Is a carbon price regressive?

- Systematic review and meta analysis based on 53 studies in 39 countries with 183 effects
- Subsidy reforms are per se not different from carbon pricing.
- More progressive study outcomes for:

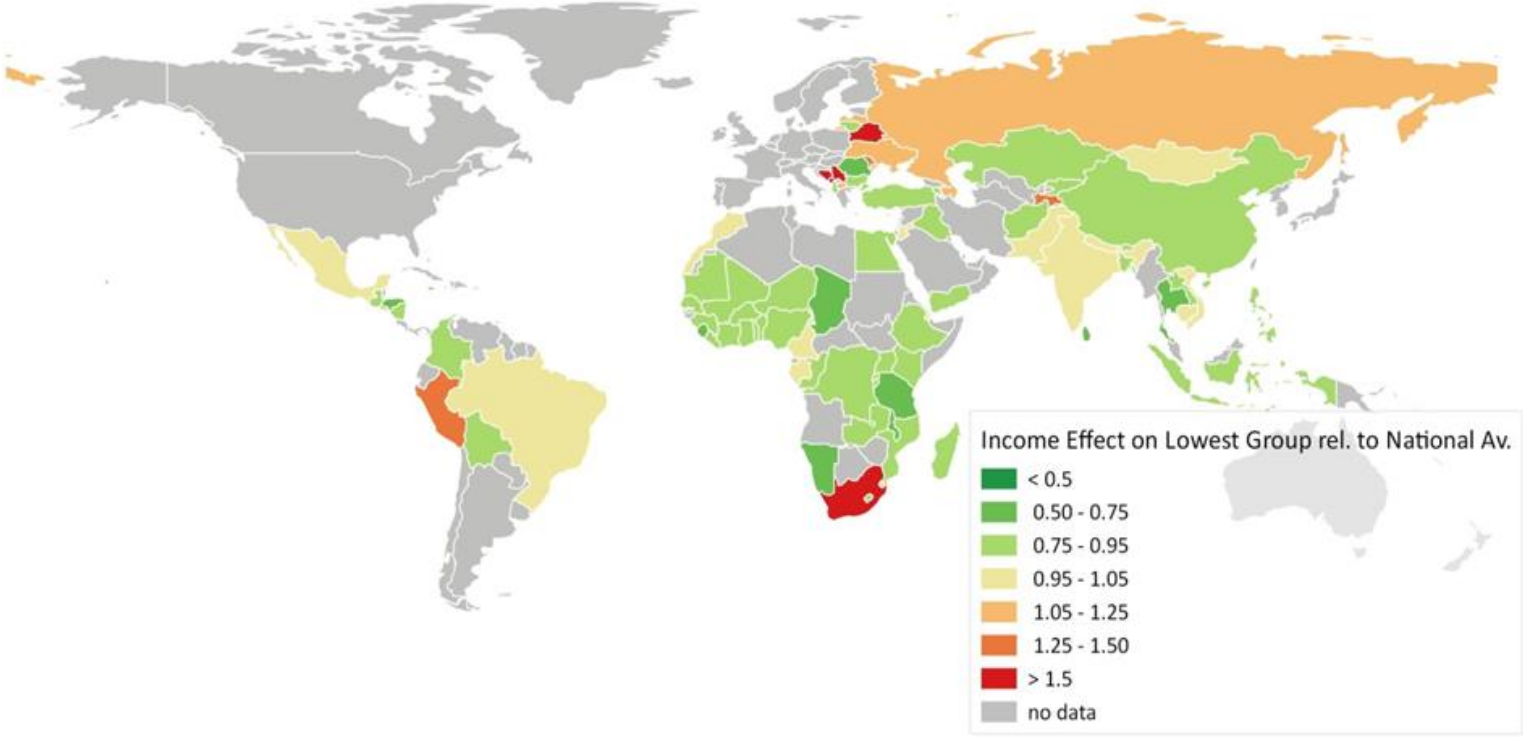
➢ **Lower income countries**

➢ **Transport sector policies**

➢ **Including additional economic effects**



Vertical distribution: Progressive vs. regressive results

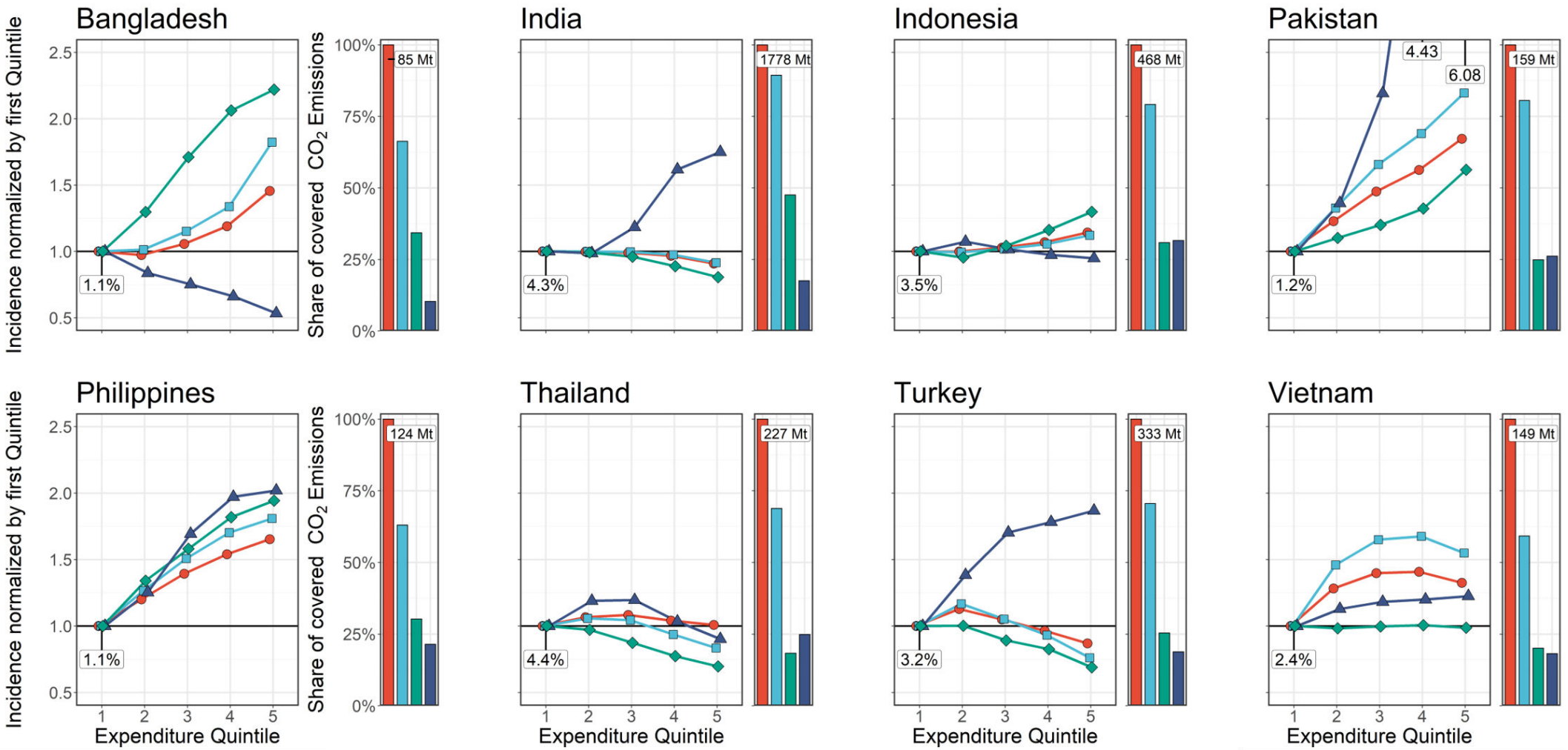


Dorband, Jakob, Kalkuhl & Steckel (2019, World Development)

Empirical analysis based on World Bank Global Consumption Database, covering 87 countries

Key result: Carbon pricing more progressive in poorer countries
Key mechanism: Differences in energy expenditures drive results

Vertical distribution: Progressive vs. regressive distribution – Design matters



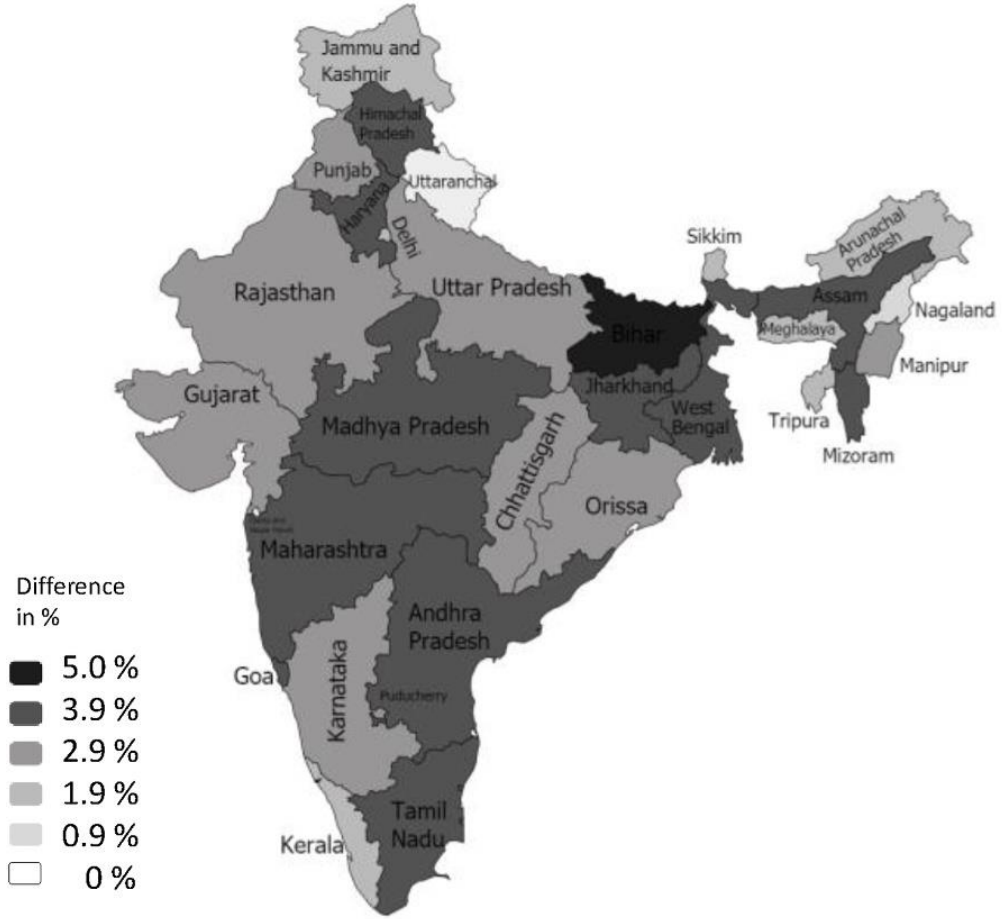
Steckel et al. (2021, Nature Sustainability)

All effects refer to carbon price of USD 40 / t CO_2

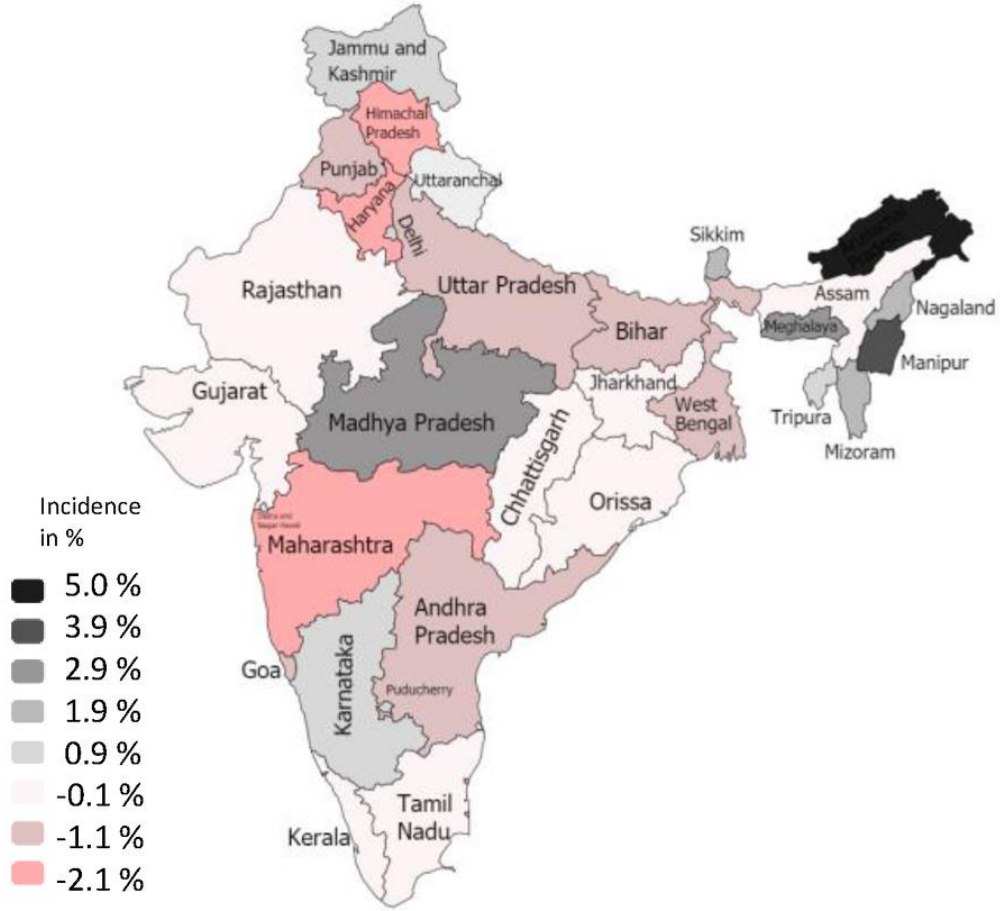
Example India: Regional dimension

Distributional effects can be very different on the regional level. But, regional level can be politically very important.

A) First quintile income incidence



B) Difference in incidence between highest and lowest quintile



Ordonez et al. 2023

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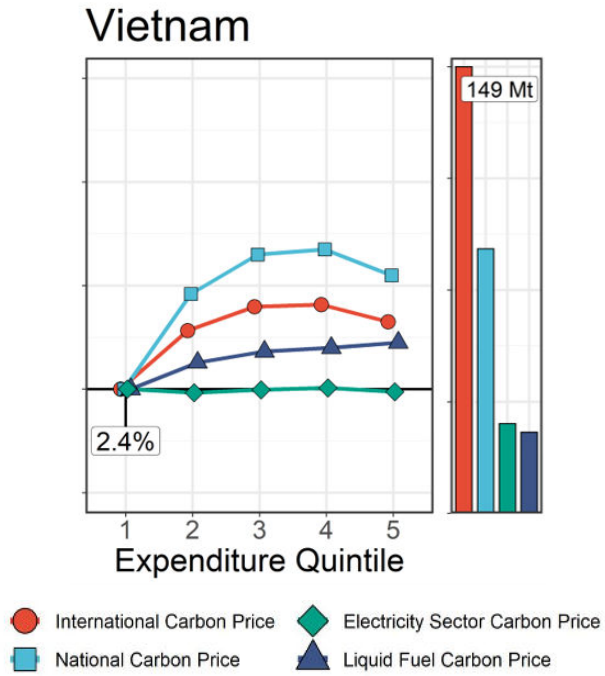
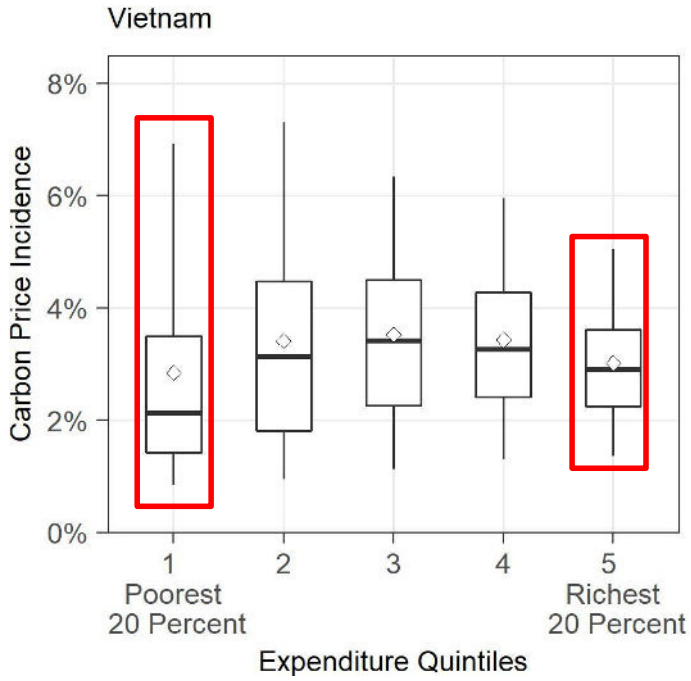
Horizontal distribution: Which households face the highest costs?

- Instead of rich vs. poor, horizontal distribution compares differences *within* income groups
  - In Vietnam, a carbon price would be progressive.
  - But not all rich households face high costs. And not all poor households face low costs.
  - Focussing on vertical effects exclusively misses out on important parts of the picture.





How to identify hardship cases methodologically?

How to describe empirically what determines being a hardship case?

- Availability of cross-sectional household data. Unavailability of exogeneous variation.
- Different concepts of „hardship case“ conceivable:
  - Highest absolute costs
  - Highest costs (relative to income) / absolute or within income group
  - Highest costs and principal accessibility to governmental transfers?
  - Capability to substitute towards cleaner goods and services?

Possible methods to distill multi-dimensional factors:

- Descriptive statistics / t-test based analysis
  - In what terms do affected and non-affected households differ from each other?
- OLS regression
- Logistic model
  - What is the probability of being especially affected conditional on income and socio-demographic factors?
- Inequality decomposition methods, variance decomposition (Fields, 2003)
- Principal component analysis, k-means clustering, gaussian mixture models, …
- …

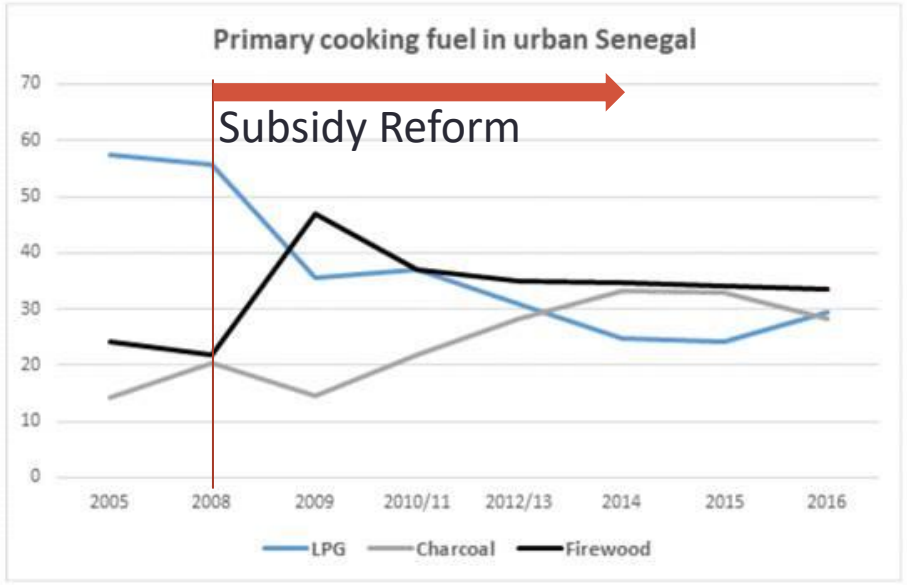
Explaining the variation of carbon price incidences

	Total expenditures (log)			Household Size			Car ownership			Cooking Fuel (Ref: Electricity)							Education			Urban			Ethnicity			Electricity access		
										Cooking Fuel			LPG		Natural Gas		Firewood												
	a	b	c	a	b	c	a	b	c	a	b	c	b	c	b	c	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Argentina	●	-	-	◑	+	+	●	+	+	○	+		+		-	-	◑	-	-								○	+	+
Barbados	●	-	-	○	+		●	+	+	◑	+	+	+	+		-	○		-				○			○	+	+
Bolivia	●	-	-	○	+	+	◑	+	+	●	-	-			-	-	○			○	+	+	○	-	-	◑	+	+
Brazil	●	-	-	○	+	+	●	+	+	○					-	-	○			◑	-	-	○	-	-	○	-	-
Chile	●	-	-	○	+	+											◑											
Colombia	●	-	-	○	+	+	◑	+	+	●	+	+	+	+	-	-	◑	-	-	○	-	-	○	-	-	○	+	+
Costa Rica	○	-	-	○	+	+	●	+	+	●	+	+			-		○	-		○	-	-	○			○	+	+
Dominican Republic	○	-	-	○	-	-	●	+	+	◑	Ref.				-	-	○	-		○	-	-				○	+	+
Ecuador	●	-	-	○	+	+	●	+	+	○	+				-	-	○			○		-	○	-	-	○	+	+
El Salvador	●	-	-	●	+	+	●	+	+	●					-	-	○	+	+	○						○		
Guatemala	○		-	○	-	-	●	+	+	●	Ref.				-	-	◑			○	+	+	◑	-	-	◑	+	+
Mexico	○	-	-	○	+	+	●	+	+	●	+	+	+	+			○	-		○		-	○	-	-	○	+	+
Nicaragua	●	+	+	○			●	+	+	●		+					○			○	-	-	○	+		○		
Paraguay	◑	-	-	○			○	+	+	●	+	+					◑	-	-	○						○	+	
Peru	●	-	-	○	+	+	○	+	+	●	+	+	-		-	-	○	-		○		+	○		+	○	+	+
Uruguay	●	-	-	○	+		●	+	+	○	+	+	+	+			○	-		●	-	-	○			○	-	-

Column **a** indicates which variables explain cumulatively at least 95% of variation in carbon pricing incidence (◑ or ●). Variables that explain by themselves at least 10% of total variance in carbon pricing incidence are marked with a full disk (●). All variables with an empty disk (○), together, contribute less than 5% of the variation in carbon pricing incidence.

Effect on the poorest: The case of cooking fuels

- Carbon taxation might be detrimental to development targets
  - Equity: Welfare losses for poor households, and susceptibility to energy poverty
  - Health: Increased biomass consumption due to fossil fuel price hikes and resulting indoor air pollution
  - Gender: Women could divert time from market work to collect firewood



Source: Rose et al., 2022

- Increasing the price of formal fuels in countries with a high penetration of traditional cooking can push people to collecting more firewood / charcoal again, with negative health effects. Also: Greve and Lay (2023): Stepping down the ladder.

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Possibilities to use revenues

Table 1 | Recycling mechanisms ranked according to efficiency, equity and acceptability

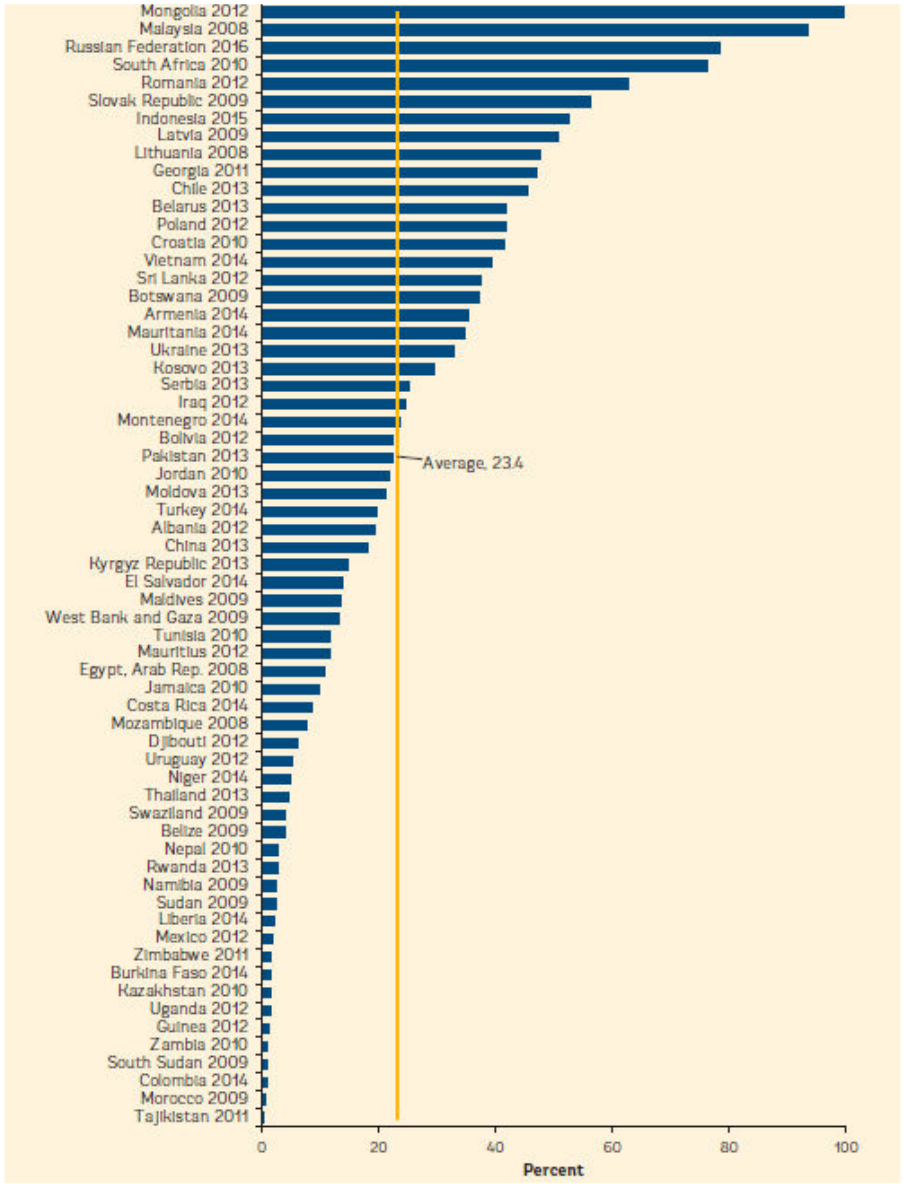
Recycling mechanism	Efficiency	Equity	Acceptability	Accessibility
Labour tax (initial system non-optimal)	+	+	0	-
Labour tax (initial system optimal)	0	0	0	-
Capital/corporate tax (initial system non-optimal)	+	–	0	-
Capital/corporate tax (initial system optimal)	0	–	0	-
Directed transfers	0	+	+	?
Uniform transfers (initial system non-optimal)	0	+	+	?
Uniform transfers (initials system optimal)	+	+	+	?

Equity and efficiency are determinants of acceptability, but the evaluation of acceptability focuses on the other factors that determine it. We use the definition of optimal as given in the section on public economics. Plus (+) and minus (–) signs indicate positive and negative evaluations, respectively, whereas 0 indicates a neutral evaluation.

Klenert et al. 2018

Investments in infrastructure? Other?

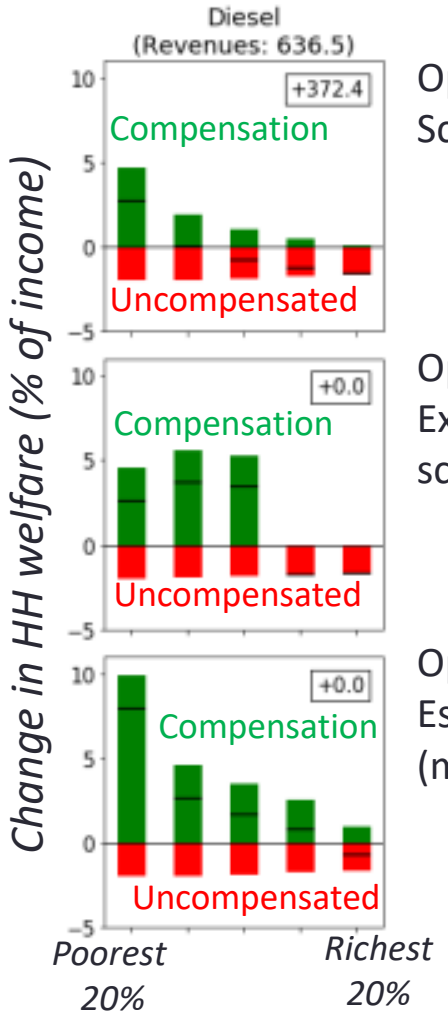
Coverage of existing social transfer schemes



World Bank, 2018

Using existing social security schemes to keep transaction costs low

- The case of Ecuador: Fossil fuel subsidy reform
- Using existing schemes vs. creating new instruments compensation
- Existing social transfer schemes can be used to make distributional outcome progressive



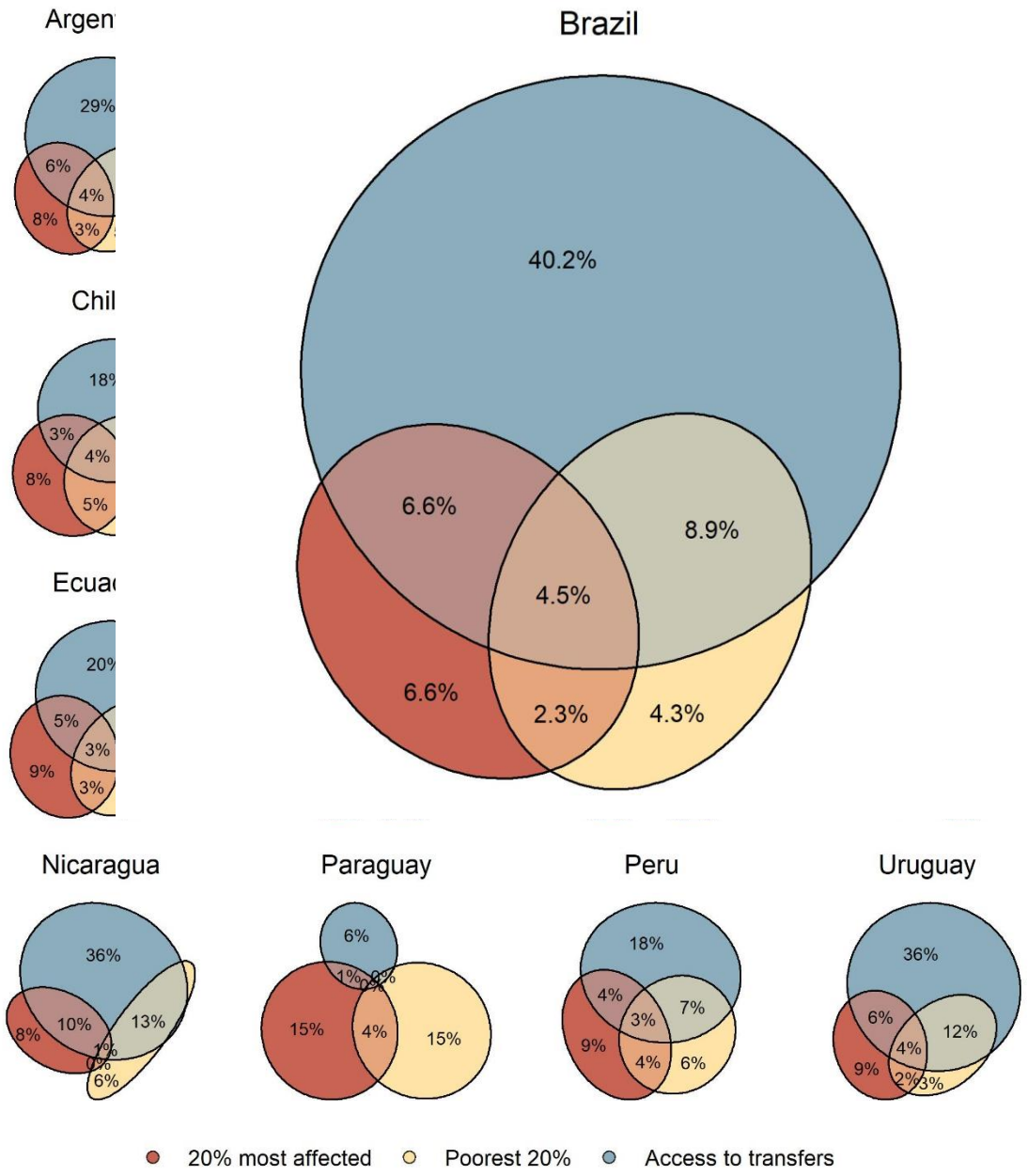
Option 1:
Scaling up existing scheme

Option 2:
Expanding eligibility of existing scheme

Option 3:
Establishing a new channel (minimum pension)

Schaffitzel et al. (2020, Energy Policy)

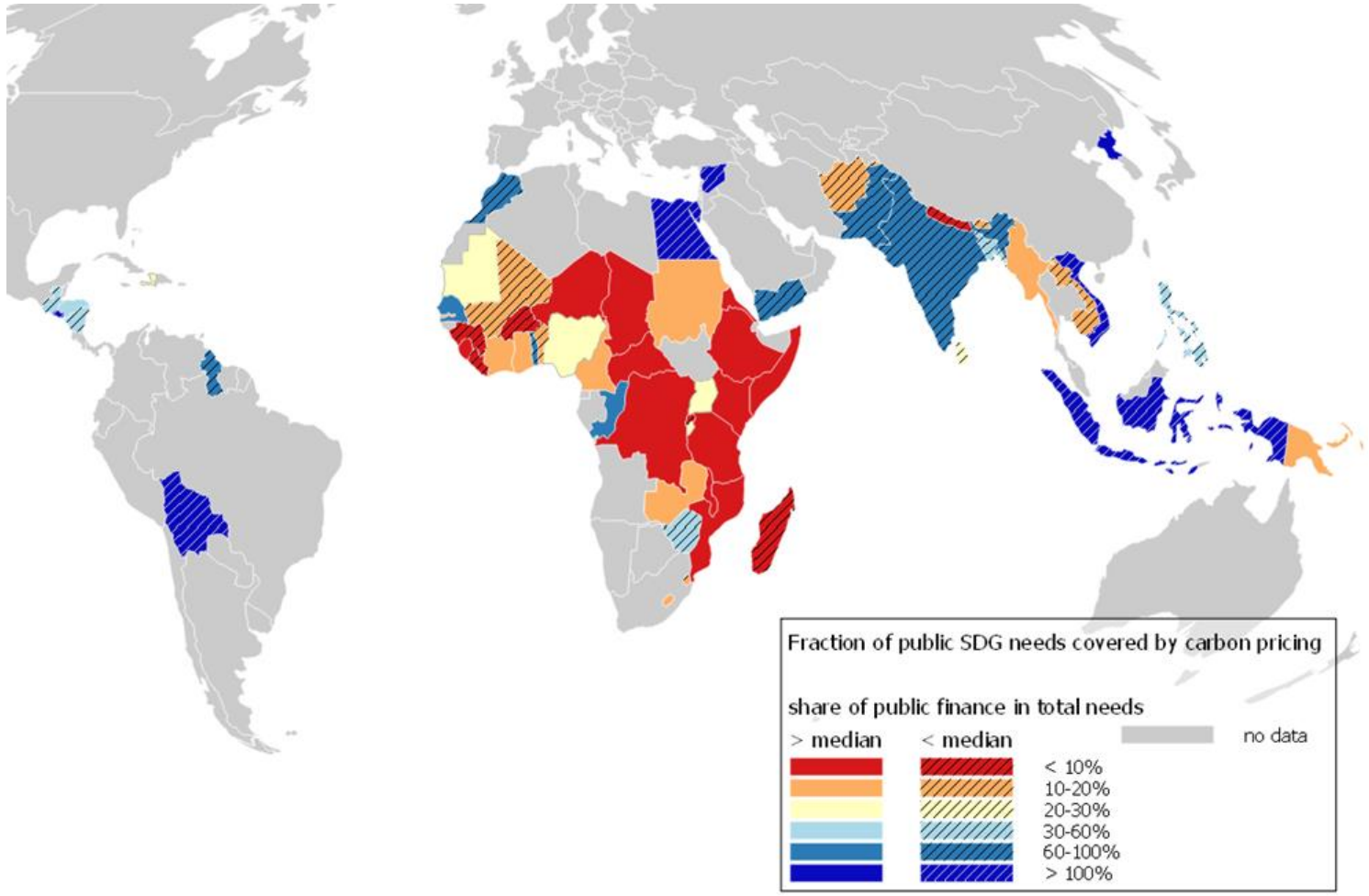
An integrative approach for Latin American countries



- Not all of the most affected households have access to transfer programmes
- Some of them are poor
- Who would be left behind?
- How to design carbon pricing and/or compensation schemes to target those that need to be targeted?

Missbach et al., R&R

Investing in (green) infrastructure



Franks et al. (2018)

Carbon pricing could **mobilize domestic resources** to finance the SDG agenda.

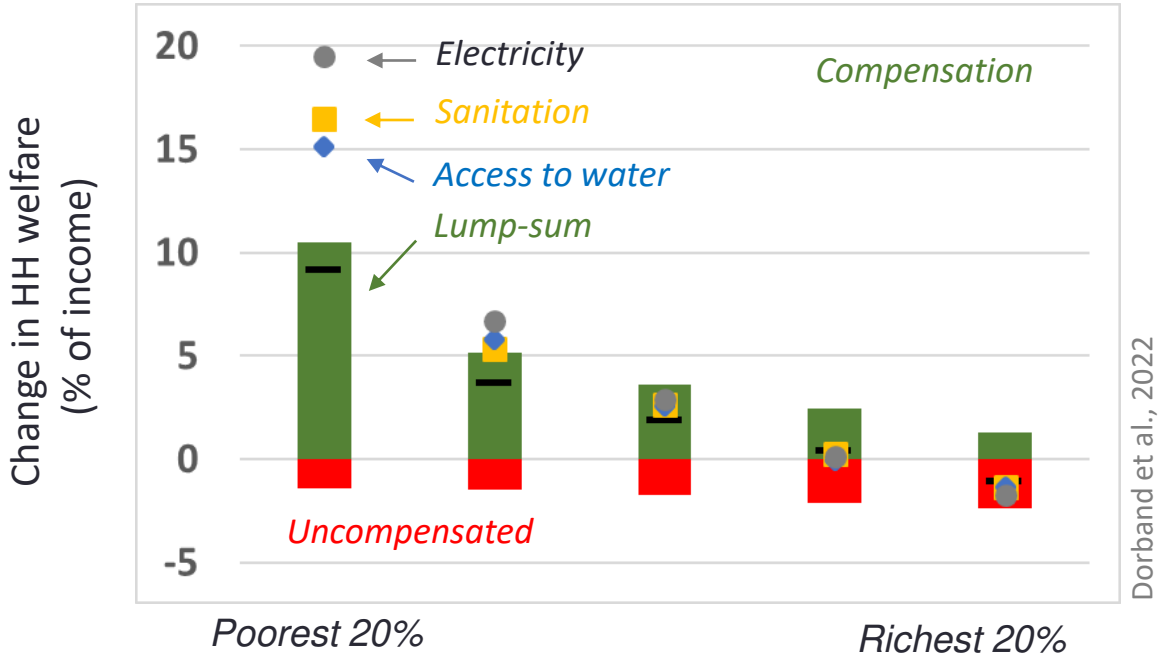
Especially promising for **middle-income countries** (higher revenues and lower gaps than LDCs).

For LDCs, most SDG funding would need to come from the **international community**.

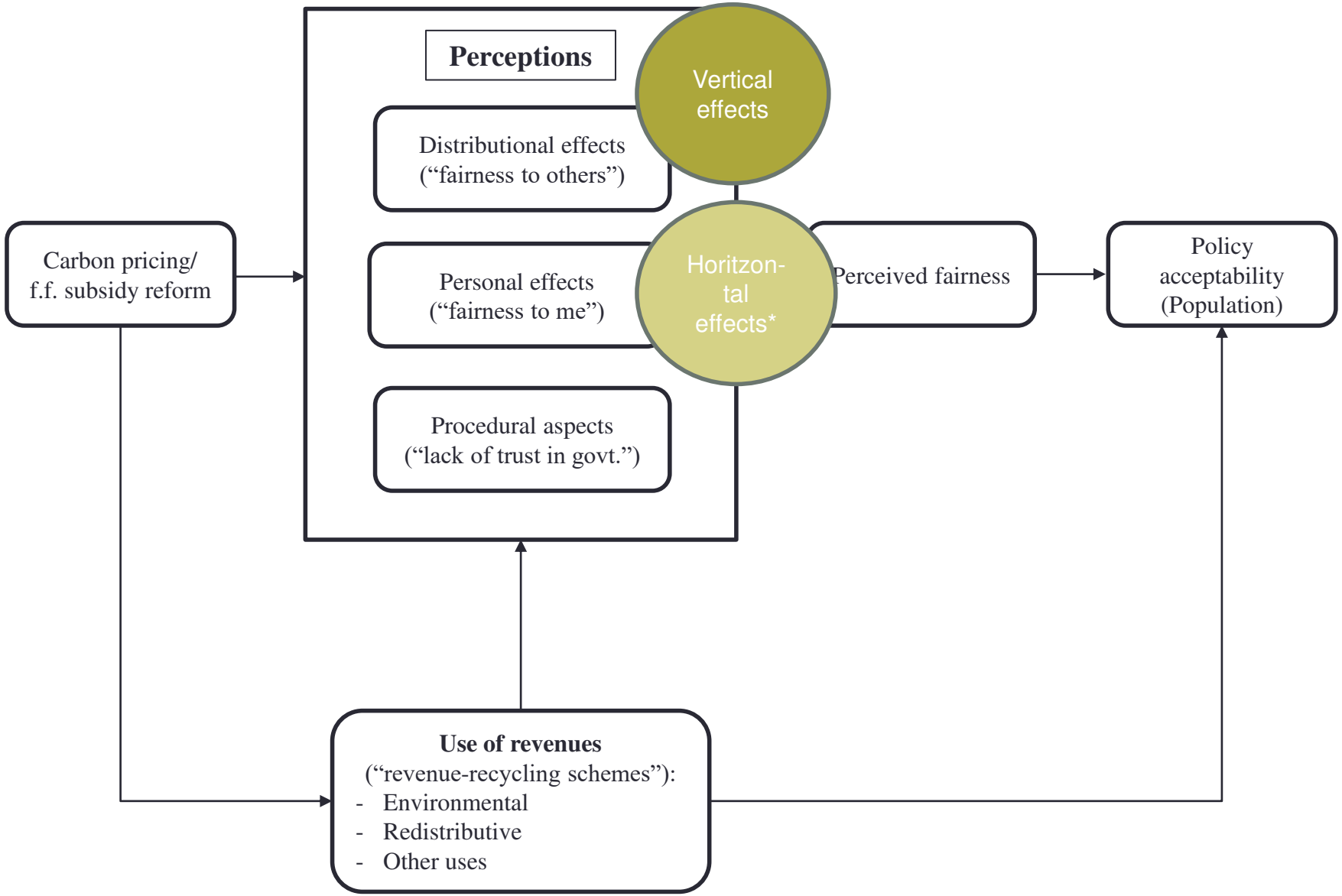
Still incentive for carbon pricing as a **source of revenue** to broaden the tax base.

Distributional effects are largely progressive

- 60% of population lack access to basic infrastructure
- Spending revenues for transfers or infrastructure investments?
- Double progressivity when using revenues to finance infrastructure investment
- But: Huge time lag, will likely not help with respect to acceptabiltiy



What determines acceptability?



Modified from Maestre-Andres et al. 2019

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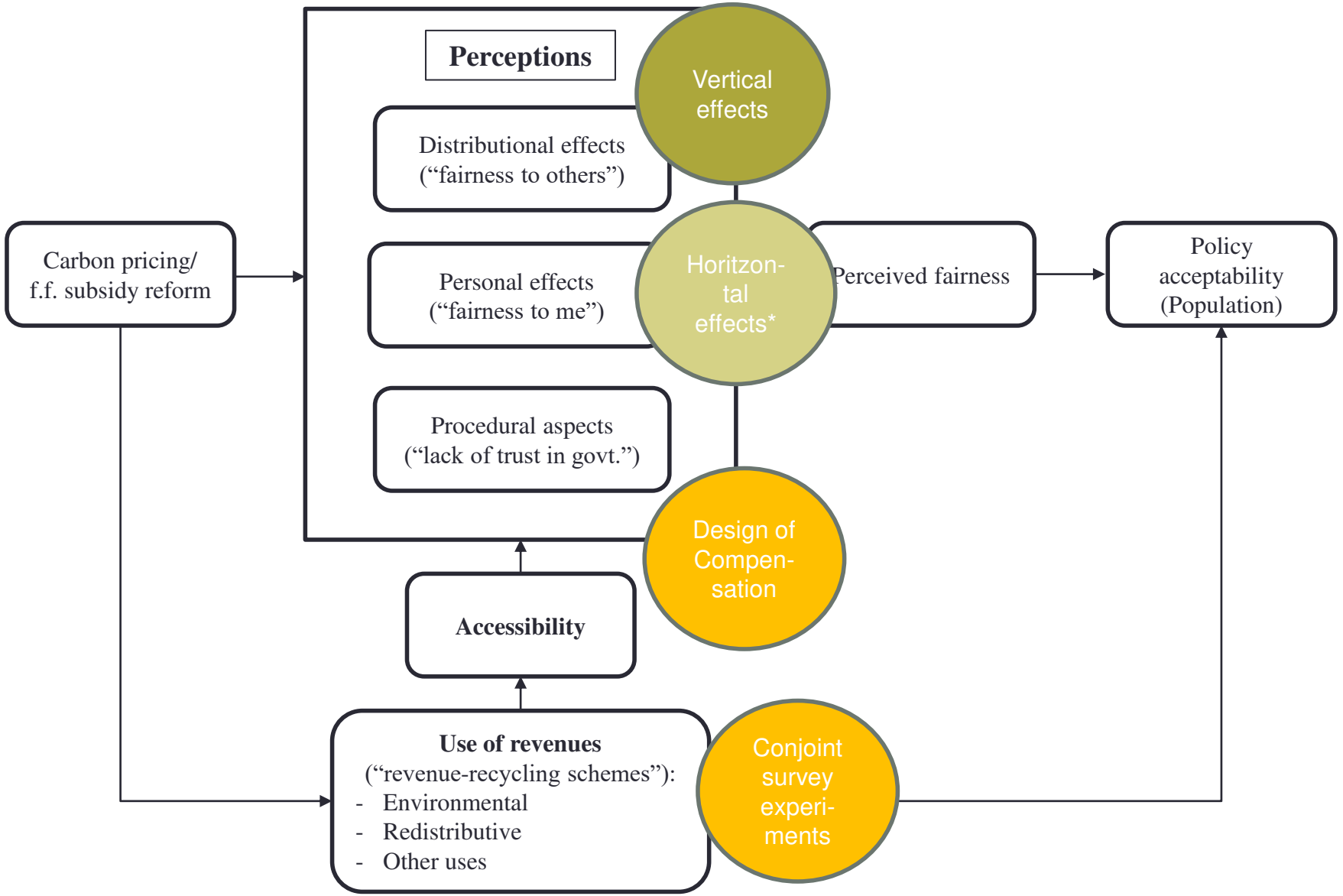


Modified from Maestre-Andres et al. 2019

Social acceptance of revenue recycling

Mildenberger et al. (2022)

Table 1 | Average estimated and true rebate sizes for sample, by province

Province	Average perceived rebate (CDN$)	True average rebate (CDN$)
Received federal rebate		
Saskatchewan	268 (13)	444
Ontario	149 (11)	217
Did not receive federal rebate		
British Columbia	63 (9)	0
Alberta	83 (9)	0
Québec	54 (10)	0

Standard errors in parentheses. See Methods for details on calculating true average rebate.

People are often not well-informed regarding the transfers they receive

Subjective evaluation closely linked to political orientation (e.g. Dounne and Fabre 2022)

How to compensate to make carbon pricing acceptable?

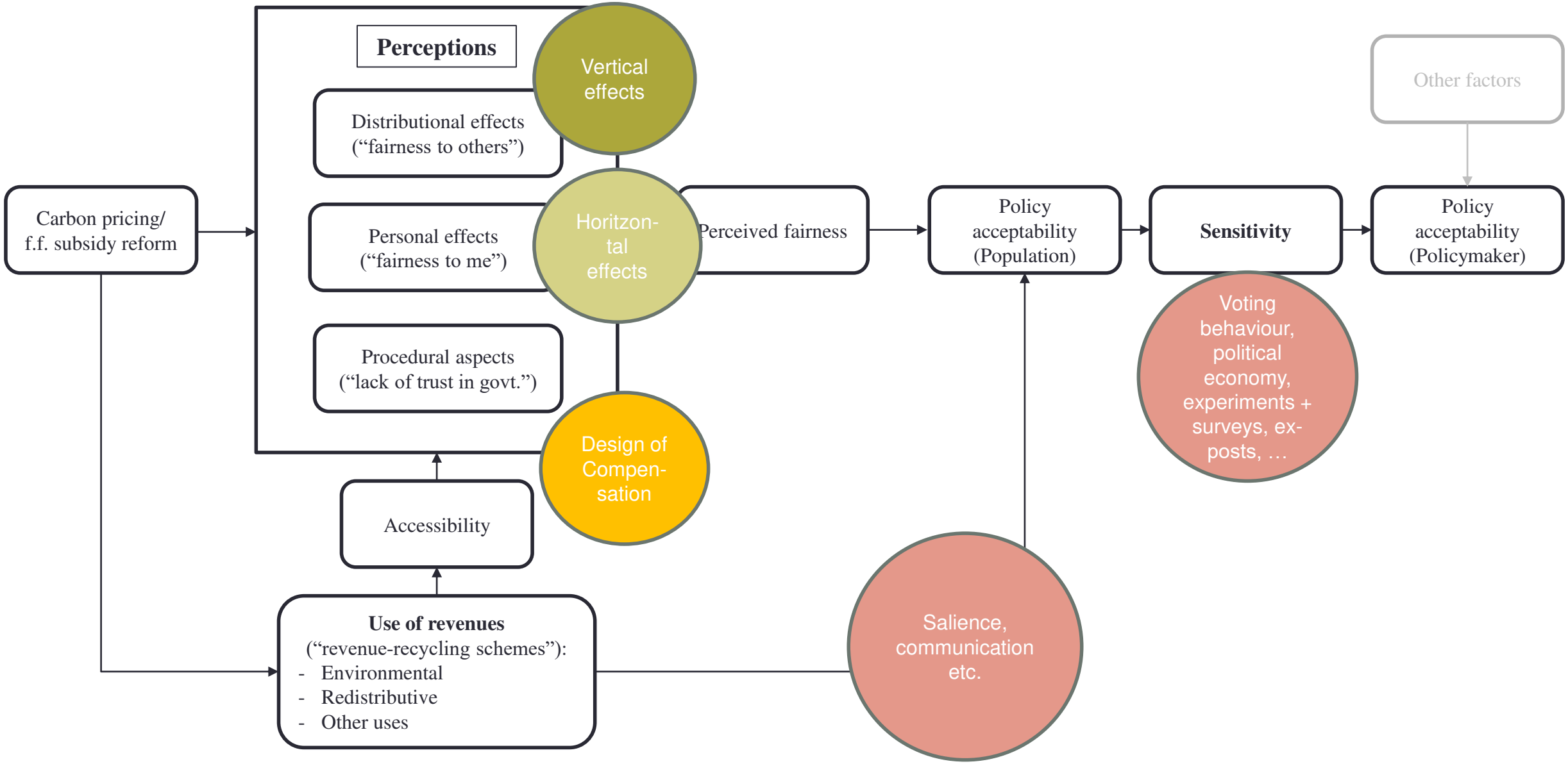
	Dep. variable: Change in public support	
	Parameter Estimate	Marginal effect at mean
Revenue recycling scheme:		
Direct transfers – entire population *(baseline: Government budget)*	-1.2 * (0.65)	-0.17
Direct transfers - targeted population *(baseline: Government budget)*	0.48 (0.57)	0.05
Green spending *(baseline: Government budget)*	2.91 * (1.23)	0.15
Tax cuts – income, labour, and consumption *(baseline: Government budget)*	0.08 (0.58)	0.01
Other – corporate tax cuts and social services *(baseline: Government budget)*	-0.55 (0.51)	-0.7
Policy type:		
Tax *(baseline: Fossil fuel subsidy reform)*	0.72 (1.76)	0.08
Carbon pricing policy in place:		
Yes *(baseline: No)*	0.81 (0.75)	0.08

Baseline specification regression coefficients with standard errors in parentheses as well as the marginal effects at mean.
Dependent variable: change in public attitude with revenue recycling scheme
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

People do not seem to like lump-sum transfers!

Results from a systematic review of the literature covering 352 observations from 69 surveys.

What's next?



Modified from Maestre-Andres et al. 2019

Thank you

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Vietnam is no exception

Table 1 | Vertical and horizontal effects of a US$40 national carbon price

	Vertical effects			Horizontal effects					Comparison	
Country	Q_{min}	Q_{max}	ΔV	ΔH_1	ΔH_2	ΔH_3	ΔH_4	ΔH_5	$\frac{\min(\Delta H_i)}{\Delta V}$	$\frac{\max(\Delta H_i)}{\Delta V}$
Bangladesh	1	5	1.1%	0.9%	0.9%	1.1%	1.6%	2.2%	0.9	2.0
India	5	1						1.9%	3.7	5.3
Indonesia	2	5						2.7%	4.8	6.1
Pakistan	1	5						1.8%	0.9	1.3
Philippines	1	5						1.1%	0.8	1.2
Thailand	5	2						2.4%	2.4	3.1
Turkey	5	2	1.3%	5.4%	5.3%	4.4%	3.4%	2.1%	1.6	4.2
Vietnam	1	4	1.6%	3.1%	3.7%	3.0%	2.6%	2.3%	1.4	2.3

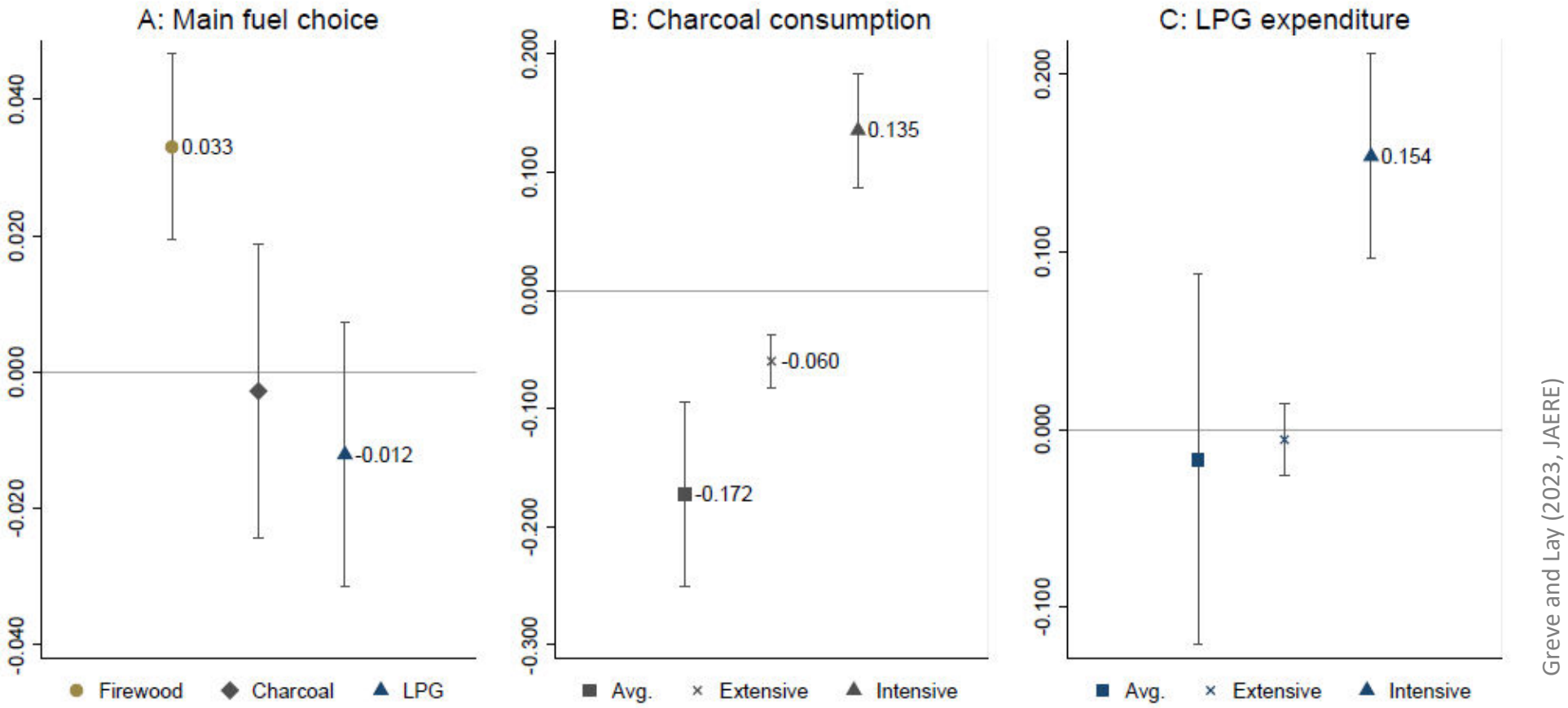
Important for policy making:
How to identify hardship cases?

Q_{min} and Q_{max} refer to the quintile that is least or most affected at the median, respectively. ΔV denotes the difference between the median values of Q_{min} and Q_{max}. ΔH_i refers to the difference between the 20th and the 80th percentile within each national quintile i. Note that underlying data were subject to outlier treatments and data cleaning (Methods and Supplementary Information). Differences between comparison column and ΔH or ΔV might arise from rounding up at all columns. Division is carried out with non-rounded values.

Steckel et al. 2021

Note that the literature has not yet settled on how to quantify horizontal effects

Stepping down the ladder: The impacts of fossil fuel subsidy removal in Ghana



Greve and Lay (2023, JAERE)

HH step down the ladder: increased # of HH mainly use firewood for cooking (3.3 percentage points)

No change in average LPG expenditure: Quantity consumed drops

Urban households increase charcoal consumption at the intensive margin by around 15 percent to substitute for LPG

Fossil fuel subsidy removals can lead to large adjustments in HH fuel choices; potential harmful implications need to be considered

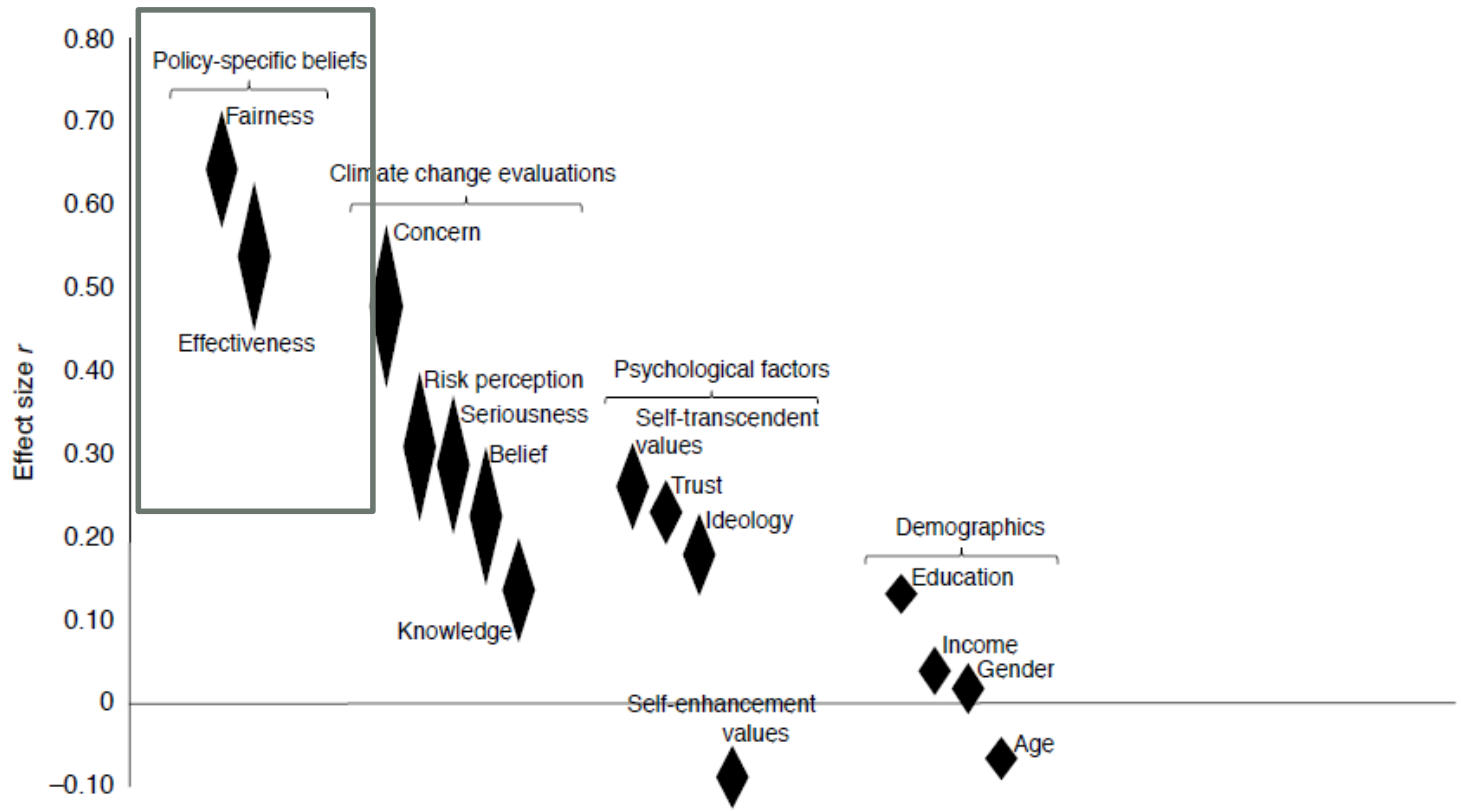
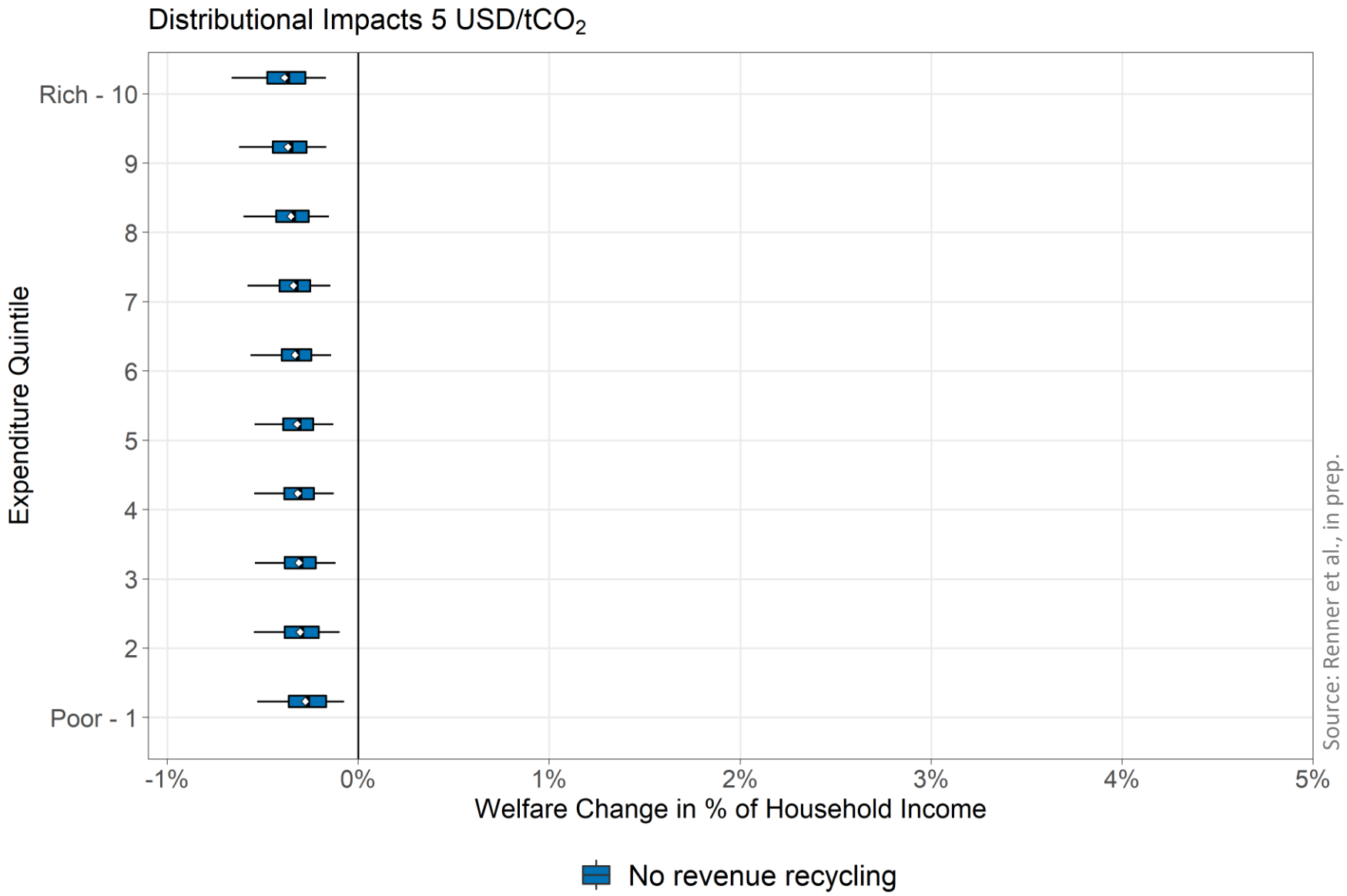


Fig. 1 | Visual summary of the relationship between determinants and public opinion about climate change taxes and laws. Higher levels of ideology represent identifying as left or liberal. Gender is coded 0, male; 1, female. Geometrical centres of the diamond shapes represent mean values and end-points represent ±95% CI.

Institutional Capability: How to compensate?



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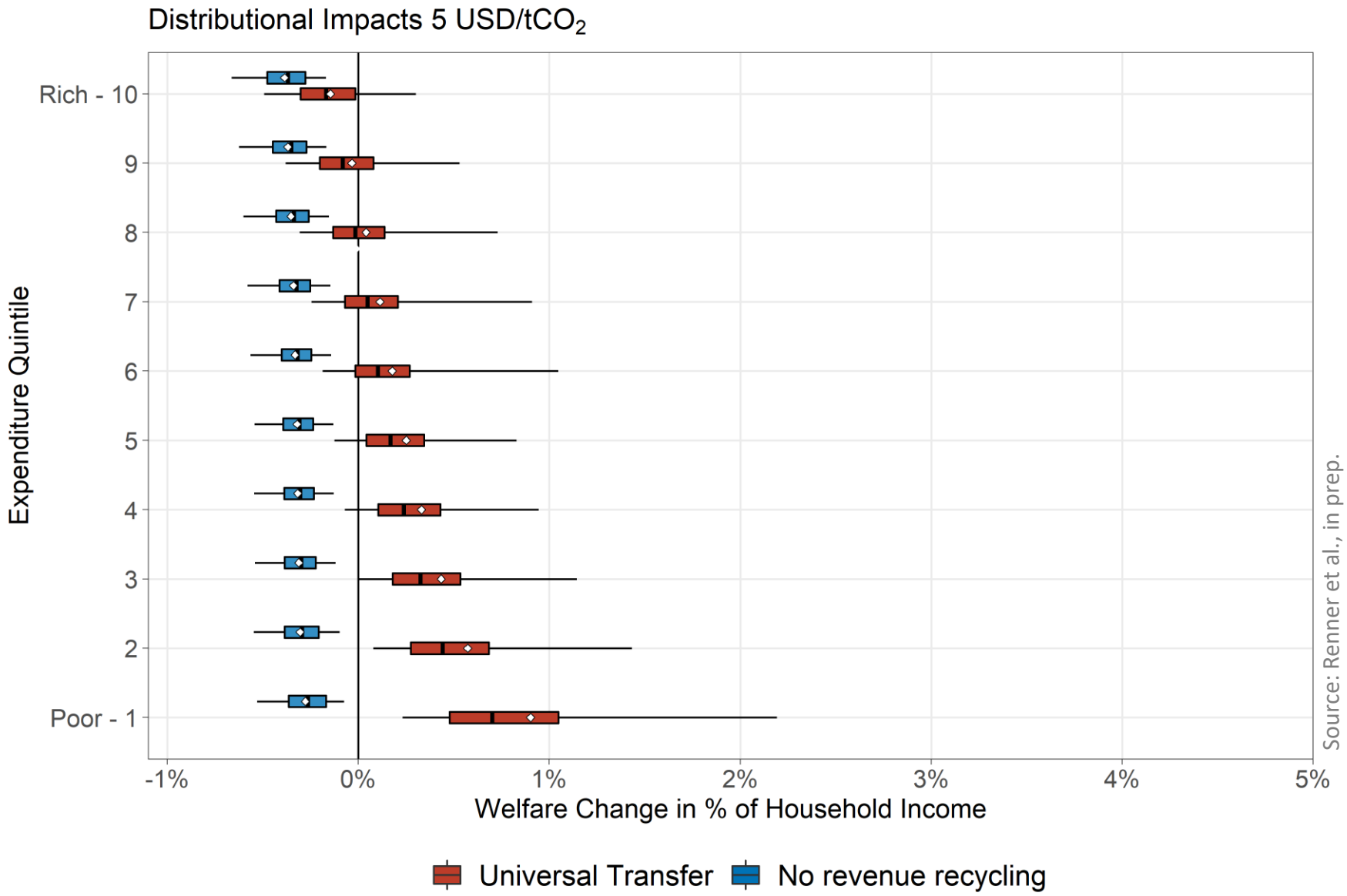

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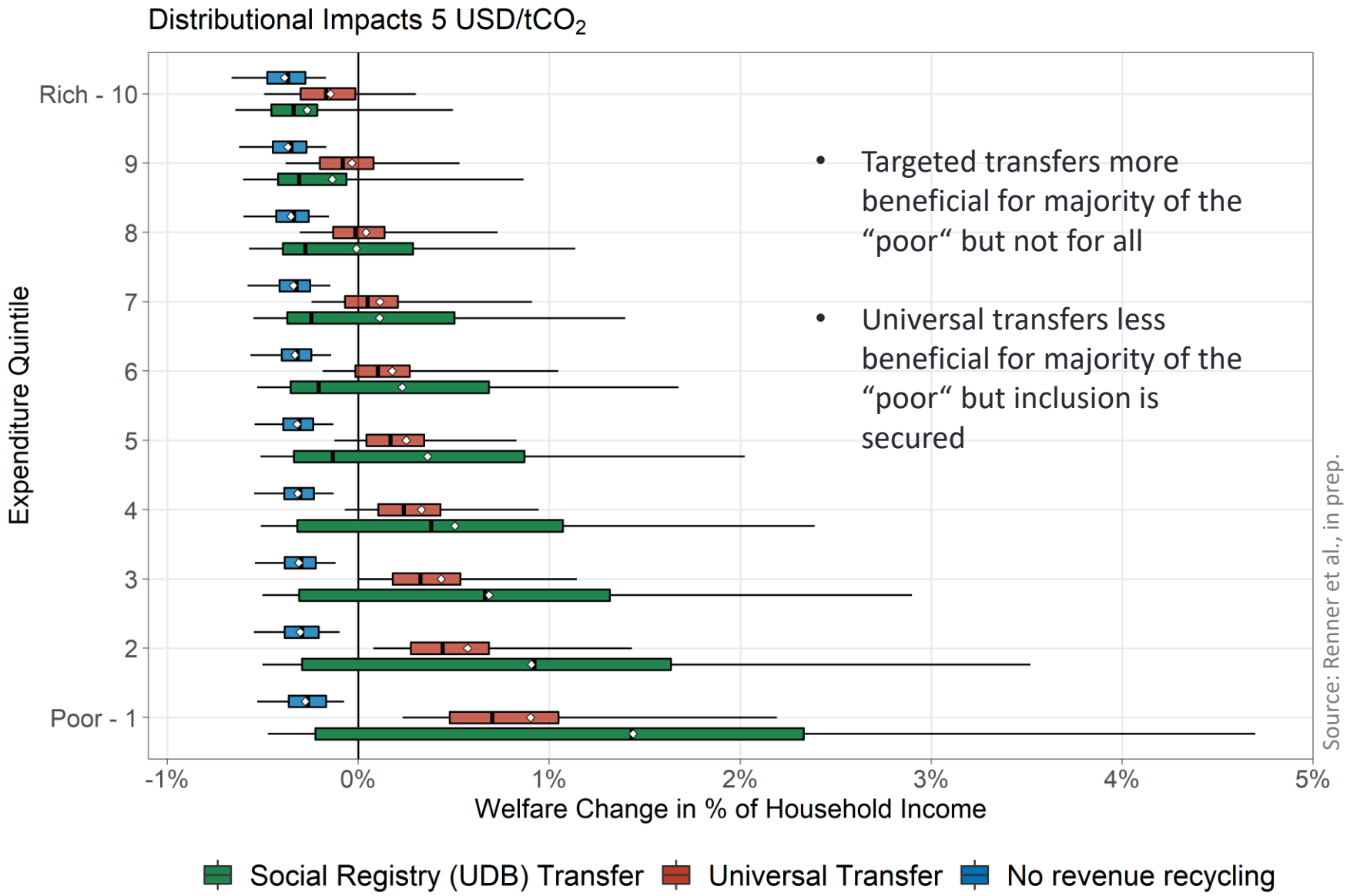
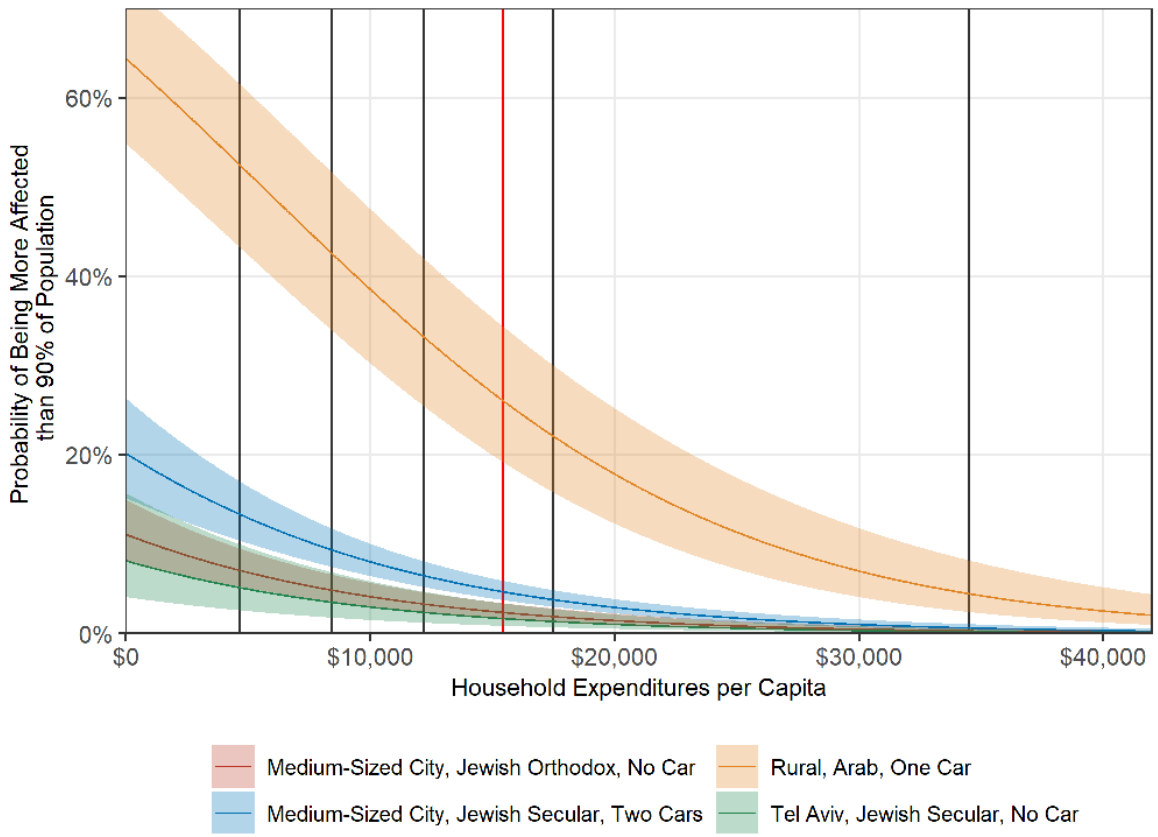


- Targeted transfers more beneficial for majority of the "poor" but not for all
- Universal transfers less beneficial for majority of the "poor" but inclusion is secured

Source: Renner et al., in prep.

Horizontal distribution: Which households are affected exactly?



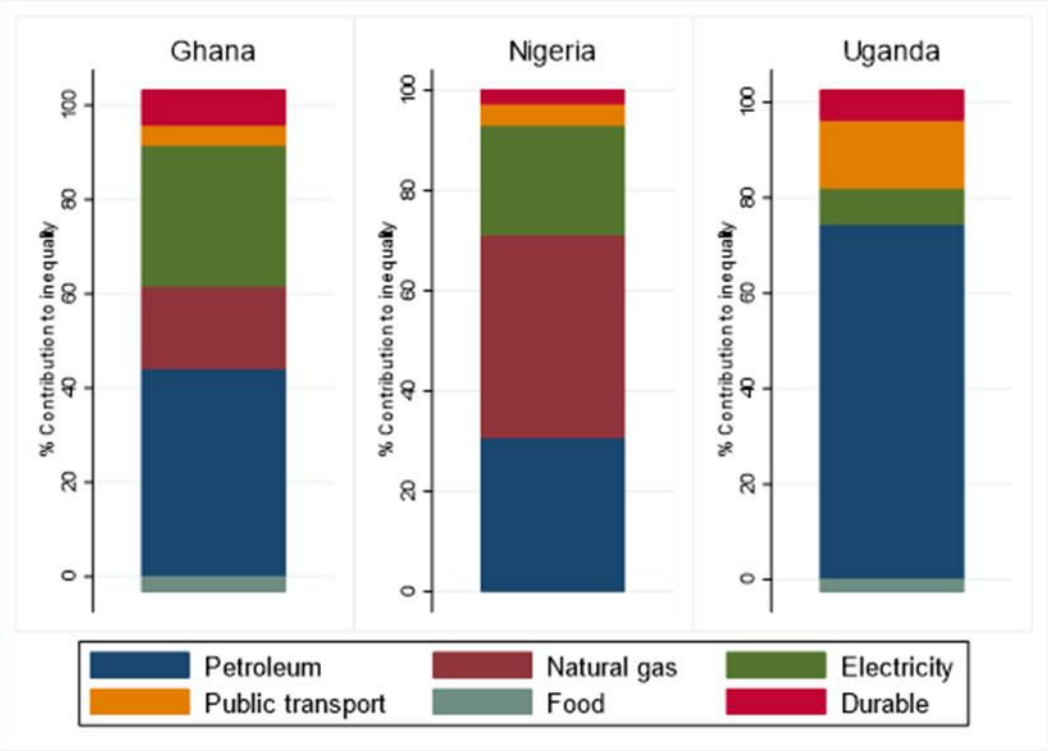
- Dialogue with Israeli stakeholders

  Which groups of society might be of particular importance in the public debate?

- Calculation of household-specific „risk profile“

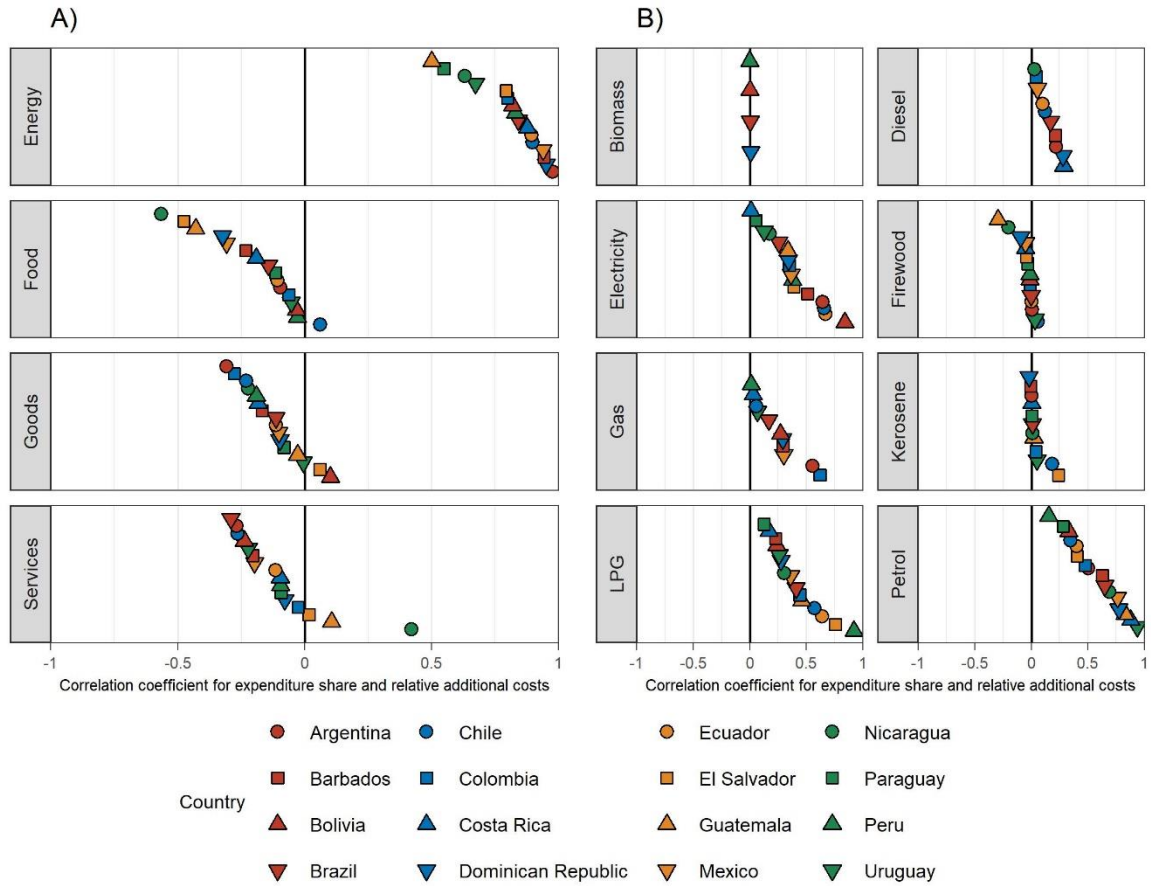
  What is the probability that a household bears relatively high costs conditional on income and socio-demographic factors?

Decomposing horizontal effects



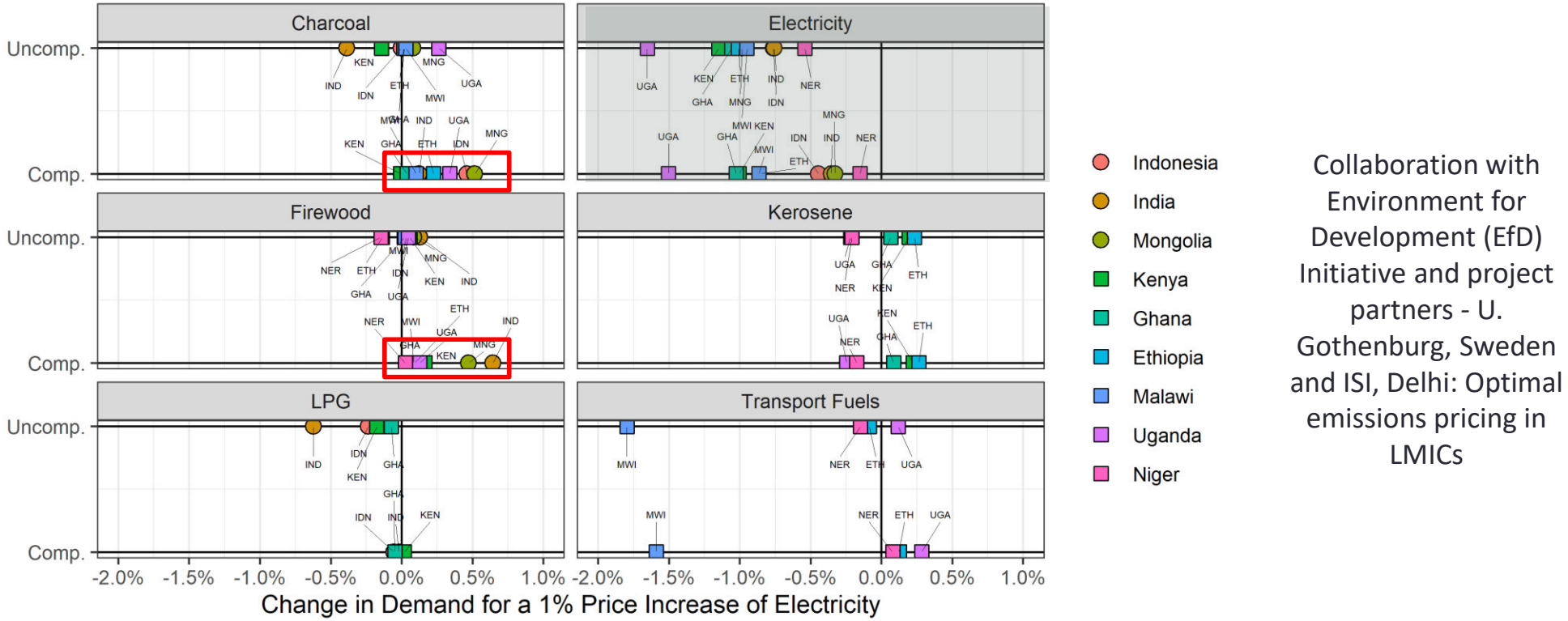
Identify the most affected households from carbon pricing through the factor source decomposition analysis (Shorrocks, 1982)

- By ranking the relative importance of each consumption category (i.e. factor) in explaining the inequality in total household carbon tax burden
- Relative contribution equals to the ratio of the covariance between a factor and total tax burden divided by the variance of the total tax burden.


A)
B)
Energy
Food
Goods
Services
Biomass
Diesel
Electricity
Firewood
Gas
Kerosene
LPG
Petrol
-1
-0.5
0
0.5
1
Correlation coefficient for expenditure share and relative additional costs
Country
Argentina
Barbados
Bolivia
Brazil
Chile
Colombia
Costa Rica
Dominican Republic
Ecuador
El Salvador
Guatemala
Mexico
Nicaragua
Paraguay
Peru
Uruguay

Cross-country energy demand analysis (consumer demand systems)

- We estimate the EASI demand system to compute price elasticities of demand for **fossil fuels vs. traditional biomass**, to understand if carbon pricing can raise demand for biomass
  - Sample of 9 LMICs (Ethiopia, Ghana, India, Indonesia, Kenya, Malawi, Mongolia, Niger and Uganda)
  - We account for censored expenditure data in household surveys by combining Tobit models with efficient GMM methods



Collaboration with Environment for Development (EfD) Initiative and project partners - U. Gothenburg, Sweden and ISI, Delhi: Optimal emissions pricing in LMICs

- Goal: Provide **menu of policy options** incl. feasible revenue redistribution and/or tax exemption for cooking fuels in LMICs