C3A Annual Symposium
December 2-6, 2024
World Bank Paris

Research Segment

Session 1
Carbon taxation, implementation and impacts

Chairs: Helia Costa (OECD) & Ornella Torres (WB/C3A)

6th December 2024 - Paris, France

C3A, a program founded and hosted by WORLD BANK GROUP

C3A Annual Symposium
December 2-6, 2024
World Bank Paris

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Carrot first, stick second? Environmental policy-mix sequencing and green technologies.

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Motivation

Eco-innovations lead to lower environmental impact
- end-of-pipe technologies
- cleaner production technologies

Public policy intervention is neeed
- high fixed costs
- uncertainty
- double externality problem (Rennings, 2000)
  - development/adoption

One instrument to address one goal/market failure (Tinbergen, 1952)

Literature Review – Static policy-mix

Policy-mixes are not a panacea

- synergies and complementaries
- But conflicts and redundancies

Static mixes

- Greco et al. (2022) cross-instrumental policy mix has a stronger impact on proces eco-innovations than innovation policy instruments alone (but not than green instruments)

- Tchorzewska et al. (2022) policy-mix of environmental taxes and public financing is synergic at low levels of environmental taxation

Until recently mostly qualitative analyses due to lack of data (del Rio, 2014; Rogge and Reichardt, 2016; Howlett et al. 2017)

Literature Review – Dynamic policy-mix

In Economics	***In Political Science***	
• Working paper by Lenihan et al. (2022) and Lenihan et al. (2024) Showing the sequential effects of R&D subsidies on patenting!	• Theoretical papers investigating the interplay between instruments and institutional barriers (Howlett, 2019; Daubjerg and Kay 2015; Pakizer et al., 2022) .	• Papers on climate policy sequencing - they show that policies at an early stage allow implementation of more stringent policies later .

Our Paper

Aim: to investigate the effects of environmental policy-mix sequencing on adoption of green technologies

- environmental tax, subsidy and tax credit

Setting: 5,823 firms, 2010-2020, Spain

Method: sequential analysis as suggested by Lenihan et al. (2022)

Results:

- The order of instruments matters
- Using subsidies first (carrots) then taxes (sticks) positively drives adoption of green technologies
  - Particularly true for small firms
- Tax credits and subsidies are sequential subsitutes (no matter the order)

Green taxes

- On air pollution, waste, coastal discharges and others
- **Implemented at regional level - substantial differences, high heterogeneity in existence and their rates**
- Critisism about their limited use (Labandeira et al. 2019)

Subsidies

- For adoption of green technologies – **energy efficient**
- **Mostly central government**
- Positive effects at the firm level (Tchorzewska et al. 2022) and industry level (Garcia-Quevedo et al. 2021)

Tax credits

- For adoption of green technologies
- **at the central level**
- **Discussion about end-of-pipe and cleaner production technologies**
- Improved precision in 2011 (Tchorzewska, 2024)
- Phase out in 2015

Unique data

Unique data from National Institute of Statistics of Spain (INE). „The Survey on Indusry Expenditure on Environmental Protection"

5,823 firms over 11 years (2010-2020)
30 sectors (2 digit leveL)
at least 10 remunerated employees

- Exact amounts of money invested in:
- Cleaner production technologies (aggregated, air pollution and energy consumption reducing)
- End-of-pipe technologies (aggregated and air-pollution reducing)

Defining the sequence

We define 3 categories of environmental policies: environmental taxes, subsidies and tax credits

- We adopt a novel approach by Lenihan et al. (2022), used to study R&D support policies
- Firms encounter policy sequences within a ”time window” which we defined as 5 years and/or 3 years
- For two years before ”the time window” begins, a firm cannot receive any subsidy/tax credit or be paying any environmental taxes

➢ this ensures that current avg investment is not a lagged response to a previous policy setting

Sequencing method

Our model is specified as follows:

- $avg\_ln\_investment_{itj} = \sum_{j=1}^{J} \beta_1 \, Zit_j + \beta_2 \, \boldsymbol{X}_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$

- where avg_ln_investment is the firm's average expenditure on different green technology adoption within the defined time window
- Our main coefficient of interest is β_2 on a policy sequence variable X
- Z includes a set of time varying control variables e.g. lagged investment, sector, size, number of green employees
- α_i *and* α_t control for unobserved time and firm level heterogeneity

Static policy-mixes

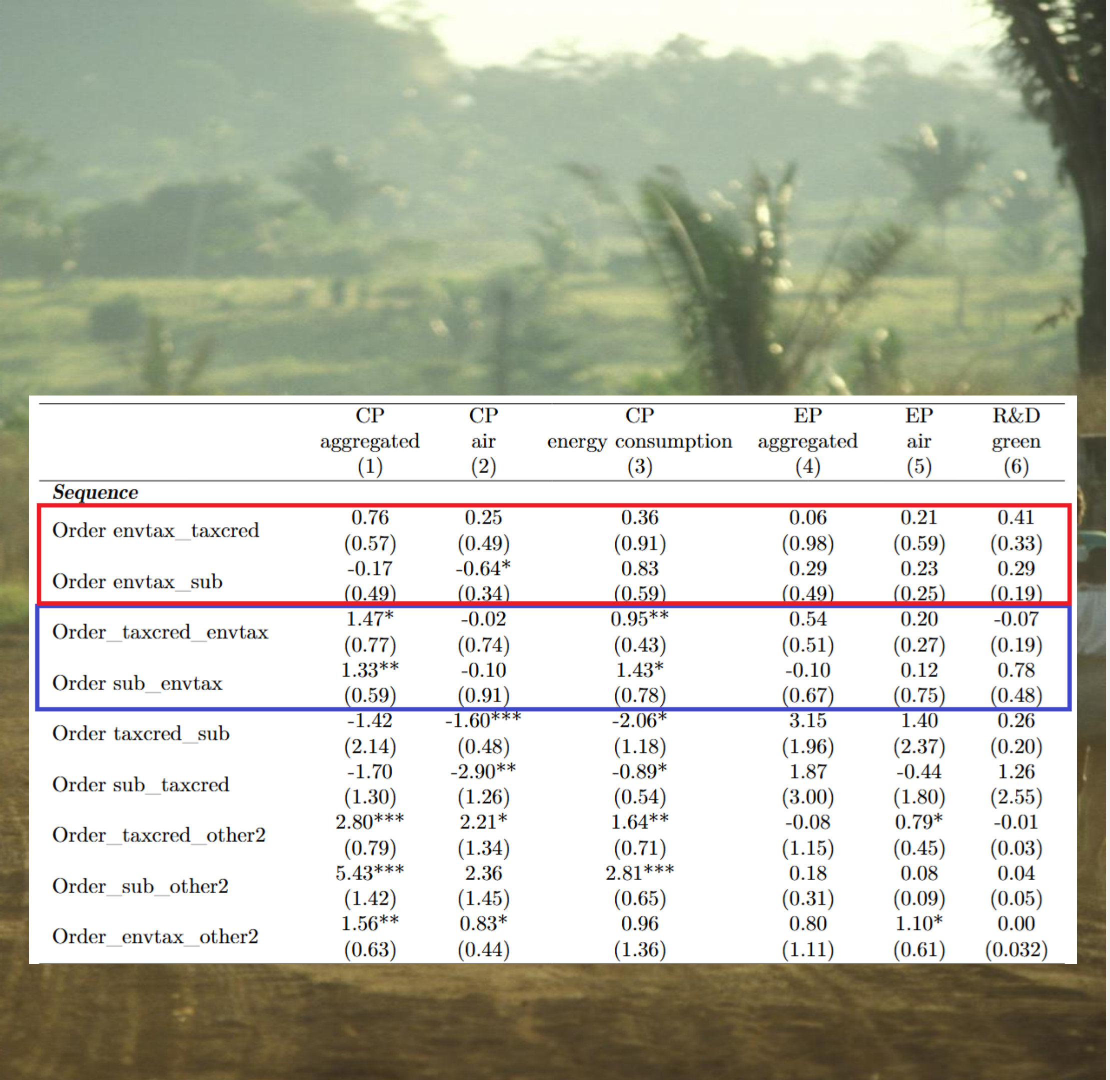
	CP aggregated (1)	CP air (2)	CP energy consumption (3)	EP aggregated (4)	EP air (5)	R&D green (6)
Repeated_taxcred	1.58	1.30	-0.34	0.89	0.16	-0.25
	(1.30)	(0.93)	(0.57)	(0.85)	(0.58)	(0.19)
Repeated_sub	1.40**	0.53	0.92	1.33*	0.31*	-0.49
	(0.64)	(0.55)	(0.60)	(0.80)	(0.18)	(0.40)
Repeated_envtax	0.12	-0.11	0.37***	0.22	0.04	0.13*
	(0.17)	(0.11)	(0.13)	(0.15)	(0.10)	(0.08)
At once						
At_once_taxcred_sub	omitted	omitted	omitted	omitted	omitted	omitted
At_once_taxcred_envtax	8.45***	3.82***	1.60***	0.08	0.08**	0.01
	(0.07)	(0.05)	(0.06)	(0.06)	(0.04)	(0.04)
At_once_envtax_sub	-0.38*	-1.57	-1.33	-3.57***	-0.06	0.72
	(0.20)	(1.15)	(1.18)	(1.09)	(0.05)	(0.47)
Once						
Taxcred	1.04	-0.49	0.86*	-0.30	-0.46*	-0.45
	(0.69)	(0.57)	(0.50)	(0.45)	(0.26)	(0.47)
Envtax	-0.07	-0.04	-0.04	-0.36	-0.07	0.00
	(0.31)	(0.23)	(0.20)	(0.31)	(0.21)	(0.18)
Sub	1.73***	0.52	0.99**	1.29***	0.72***	0.18
	(0.49)	(0.36)	(0.40)	(0.47)	(0.25)	(0.15)

- Repeated subsidies drive mostly inferior end-of-pipe technologies
- Repeated environmental tax drives Energy efficient technologies (CP reducing Energy consumption)
- Receiving at once environmental tax and tax credit is positively correlated with CP technologies

	CP aggregated (1)	CP air (2)	CP energy consumption (3)	EP aggregated (4)	EP air (5)	R&D green (6)
Sequence						
Order envtax_taxcred	0.76	0.25	0.36	0.06	0.21	0.41
	(0.57)	(0.49)	(0.91)	(0.98)	(0.59)	(0.33)
Order envtax_sub	-0.17	-0.64*	0.83	0.29	0.23	0.29
	(0.49)	(0.34)	(0.59)	(0.49)	(0.25)	(0.19)
Order_taxcred_envtax	1.47*	-0.02	0.95**	0.54	0.20	-0.07
	(0.77)	(0.74)	(0.43)	(0.51)	(0.27)	(0.19)
Order sub_envtax	1.33**	-0.10	1.43*	-0.10	0.12	0.78
	(0.59)	(0.91)	(0.78)	(0.67)	(0.75)	(0.48)
Order taxcred_sub	-1.42	-1.60***	-2.06*	3.15	1.40	0.26
	(2.14)	(0.48)	(1.18)	(1.96)	(2.37)	(0.20)
Order sub_taxcred	-1.70	-2.90**	-0.89*	1.87	-0.44	1.26
	(1.30)	(1.26)	(0.54)	(3.00)	(1.80)	(2.55)
Order_taxcred_other2	2.80***	2.21*	1.64**	-0.08	0.79*	-0.01
	(0.79)	(1.34)	(0.71)	(1.15)	(0.45)	(0.03)
Order_sub_other2	5.43***	2.36	2.81***	0.18	0.08	0.04
	(1.42)	(1.45)	(0.65)	(0.31)	(0.09)	(0.05)
Order_envtax_other2	1.56**	0.83*	0.96	0.80	1.10*	0.00
	(0.63)	(0.44)	(1.36)	(1.11)	(0.61)	(0.032)

Carrot first stick second

Combination of tax credit/subsidy first, environmental tax second is positively correlated with adoption of superior cleaner production technologies



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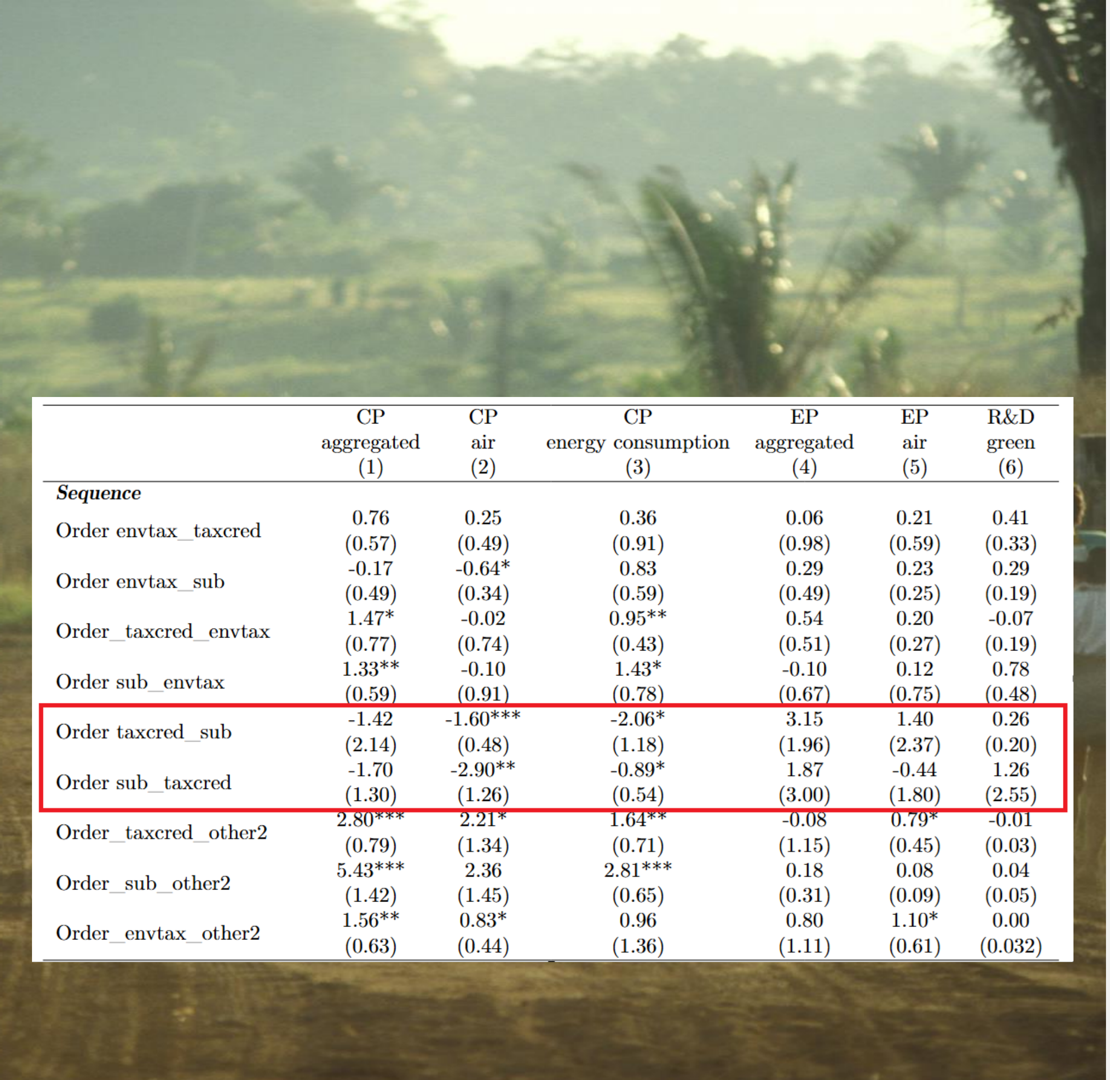
Carrot first stick second

Combination of tax credit/subsidy first, environmental tax second is positively correlated with adoption of superior cleaner production technologies

Contrarily, the combination environmental tax first, subsidy/tax credit later yields no statistically significant coefficients (negative one on CPair)



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	(0.63)	(0.44)	(1.36)	(1.11)	(0.61)	(0.032)

Carrot over carrot

Combination of tax credit and subsidy in any oder is

negatively correlated with investment in superior cleaner production technologies,

no effect observed on end-of-pipe technologies or green R&D

Multiple instruments sequencing

	CP aggregated (1)	CP air (2)	CP energy consumption (3)	EP aggregated (4)	EP air (5)	R&D green (6)
Sequence						
Order envtax_taxcred	0.76	0.25	0.36	0.06	0.21	0.41
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	(0.63)	(0.44)	(1.36)	(1.11)	(0.61)	(0.032)

Combining more than 2 policy instruments in a sequence leads to higher adoption of cleaner production technologies

Higher coefficients present when tax credit or a subsidy is applied first. (carrot first, stick and carrot later)

Robustness & Extensions

We have run robustness checks to verify that the results hold

- Related dependent variable (environmental R&D)
- Alternative time window – 3 year window
- Modified database (only subsidy receivers)
- Modified database (only green technology adopters)
- Arellano-bond model
- Tobit model

- Heterogeneous analysis with respect to size (small firms predominately reliant on tax credits)

Conclusions *& policy recommendations*

We find evidence for a higher positive correlation between the sequence of "carrot first stick second" and green technology adoption (sequential complements)

We find evidence for negative correlation between the sequence "subsidy and tax credit" in any order (sequential substitutes)

- **Start with carrots:** Grants or tax deductions should precede environmental taxes (or at least be implemented simultaneously).
- **Avoid redundancies:** Combining tax deductions and subsidies does not amplify their effects; it increases costs without additional benefits.
- **Focus on SMEs:** Small and medium-sized enterprises benefit the most from a carrot-first strategy, as they are more sensitive to initial financial constraints.

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Thank you

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After earning her Ph.D. in Economics from the University of Barcelona, she worked as a postdoctoral researcher at ZEW Mannheim and the University of Mannheim. She also participated in research exchanges at the University of Illinois at Urbana-Champaign and Washington State University.

She has collaborated with international organizations such as the OECD, the Green Fiscal Policy Network (IMF, UNEP, GIZ), and the World Bank, focusing on evaluating green fiscal policies.

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International spillovers of asymmetric climate mitigation policies

Agnès Bénassy-Quéré, Katheline Schubert, Ornella Torres

Contact: | LinkedIn profile

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1

Motivation

Motivation

- The transition is capital intensive
  → substitution of fossil resources with capital
  → need for additional investment, the cost of capital is key.
- Asymmetric policies / asymmetric countries
  → create international spillover effects.
- Missing role of open economy in the literature
  → 2 regions with endogenous r

What are the spillovers of mitigation policies through the international capital market?

How will the transition affect capital markets?

<u>Mixed evidence on the evolution of r∗ :</u>

↑
- climate damages and uncertainty [Mongelli et al., 2022]
- green investment and subsidies [IMF, 2023]

↓
- climate policies implemented orderly [Mongelli et al., 2022]
- carbon taxation [IMF, 2023]

<u>The financing mean matters for r ∗ :</u>

- Public or private investment?
  - ➢ Evidence of crowding-in effects of public investment in renewable energies, transport and industry [Azhgaliyeva et al., 2023] [Pereira, 2001]
- Debt financing?
  - ➢ Fiscal neutral policy ↓ or deficit-funded fiscal stimulus ↑ [IMF, 2023]
  - ➢ Whether government debt crowds out private investment depends on the policies [Traum & Yang, 2015]

2

The model

Overview of the model

Two regions

- Symmetric calibration
  → 2 advanced economies (Europe / United States)
- Divergent policies
  → IRA, EU ETS
- Significant disparity in exposure to energy prices hikes
  → Importer of fossil resources (EU) versus exporter (US).

Overview of the model

<u>In each region</u>

Two types of agents :
- Ricardian and non-Ricardian

Four goods :
- Clean "Home" and "Foreign"
- Dirty "Home" and "Foreign"

Two types of assets :
- Capital and government bonds

Overview of the model

<u>In each region</u>

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- Ricardian and non-Ricardian

Four goods :
- Clean “Home” and “Foreign”
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Two types of assets :
- Capital and government bonds

→

- Consume aggregate bundle **home/foreign production**
- Supply **labor**
- Invest in **capital**
- Invest in **domestic/foreign bonds** (friction of investing abroad)

Overview of the model

In each region

Two types of agents :
- Ricardian and non-Ricardian

Four goods :
- Clean "Home" and "Foreign"
- Dirty "Home" and "Foreign"

Two types of assets :
- Capital and government bonds

In each region, 2 sectors:

Clean: $Y_t^c = \text{CES}(L^c, U_t)$

$$U_t = [\gamma(\underbrace{K_{t-1}^c}_{\text{Clean capital}})^{\frac{\eta-1}{\eta}} + (1-\gamma) \underbrace{G_{t-1}^{\frac{\eta-1}{\eta}}}_{\text{Public capital}}]^{\frac{\eta}{\eta-1}}$$

Dirty: $Y_t^d = \text{CES}(L^d, Z_t)$

$$Z_t = (\zeta \underbrace{K_{t-1}^d}_{\text{Dirty capital}}{}^{\frac{\psi-1}{\psi}} + (1-\zeta) \underbrace{E_{f,t}^{\frac{\psi-1}{\psi}}}_{\text{Fossil fuel consumption}})^{\frac{\psi}{\psi-1}}$$

Overview of the model

<u>In each region</u>

Two types of agents :
- Ricardian and non-Ricardian

Four goods :
- Clean “Home” and “Foreign”
- Dirty “Home” and “Foreign”

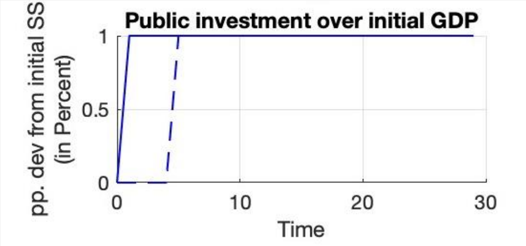
Two types of assets :
- Capital and government bonds

→ The government invests in **public clean capital financed by debt, stabilized by a tax on labor income.**

3

Application to a green investment boom

A story of "twin deficits": the effects of anticipation



Investment boom → fall in the current account

Short-term: rise in savings → rise in current account

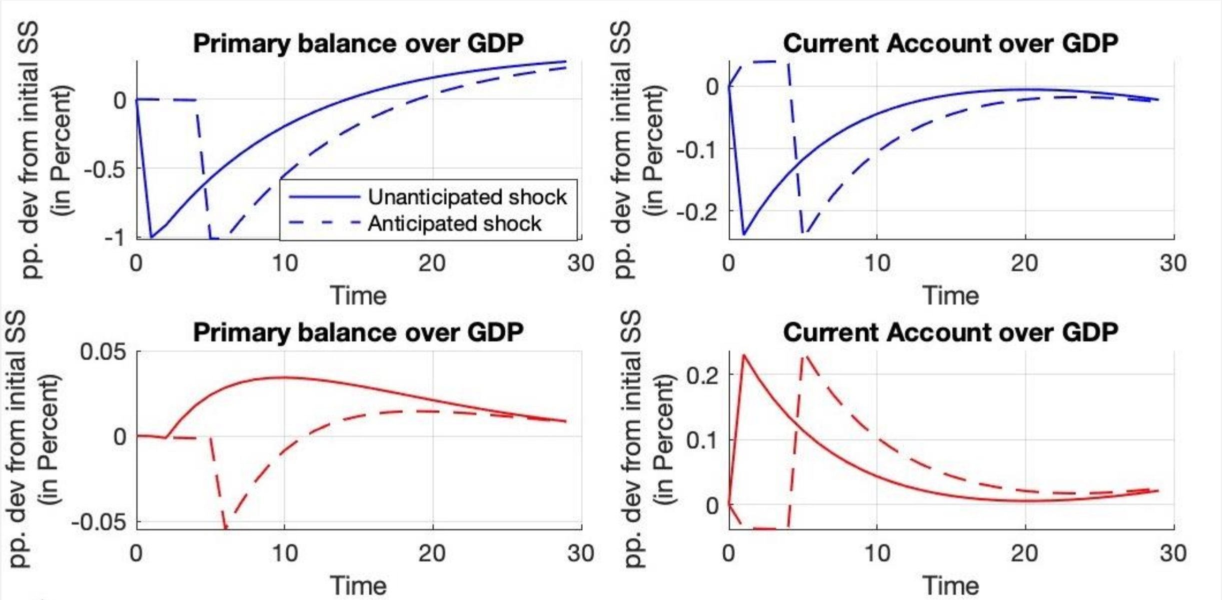


Fig 1: Europe - Shock of clean public investment of 1% of initial GDP per year in Europe, financed by debt

The role of international capital markets

Savings are ex ante insufficient, the interest rate goes up.

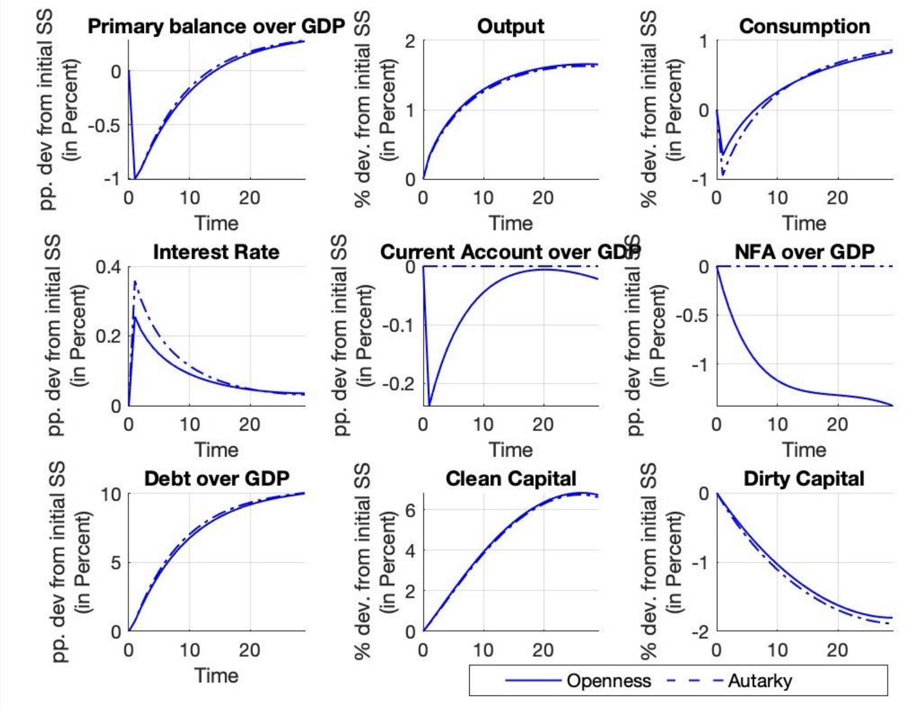


Fig 2: Europe - Unexpected persistent shock of clean public investment of 1% of initial GDP per year at t=1 in Europe

The role of international capital markets

Euro appreciates then depreciates, r > r∗.

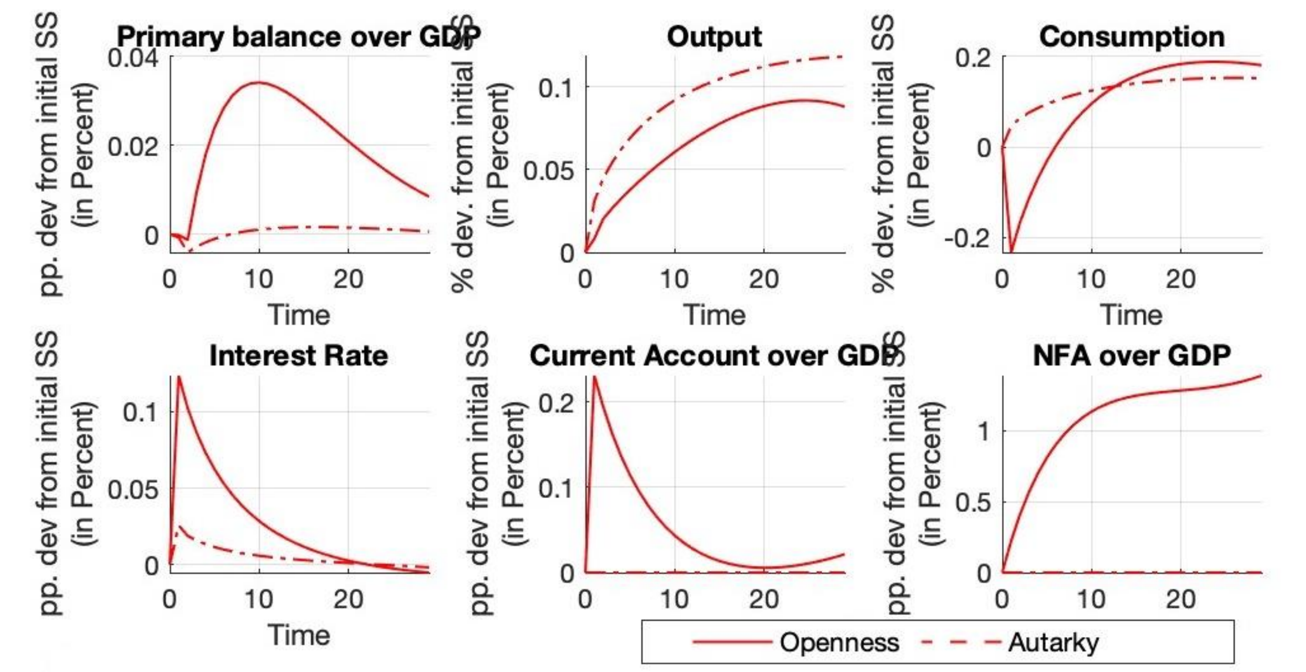
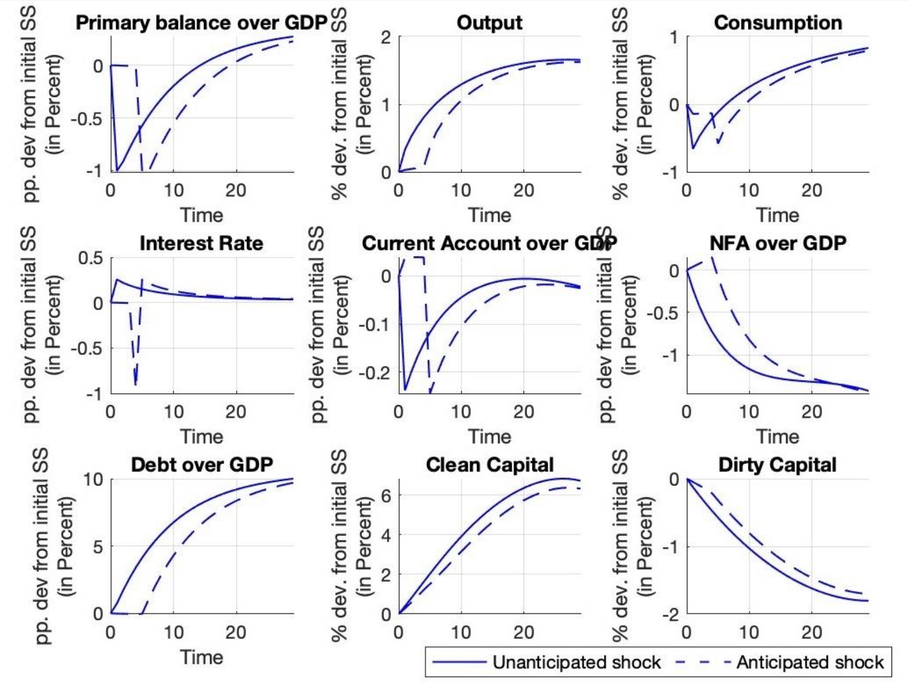


Fig 3: United States - Unexpected persistent shock of clean public investment of 1% of initial GDP per year at t=1 in Europe

The role of anticipations

Public debt increases more slowly, private savings are ex ante excessive, the interest rate decreases.



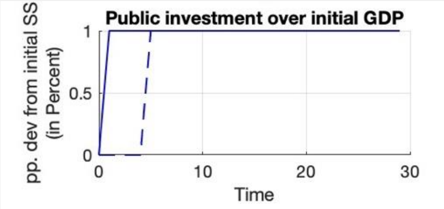


Fig 4: Europe - Shock of clean public investment of 1% of initial GDP per year in Europe

Conclusion

- Role of savings/investment decisions in the evolution of the interest rates
- Financing of the investment boom matters
- Driving role of interest rates in the transmission of the shock
- Cross-border financial flows increase international risk sharing

Y

Q&A
Discussion

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Thank you

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Appendix A - Calibration

Parameter	Value	Description	Source
Households			
μ	0.03	rate of time preference	[Henriet et al., 2014]
ϵ	0.3	share of hand-to-mouth	[Traum & Yang, 2015]
Production			
δ_k	0.10	depreciation rate of capital	[Henriet et al., 2014]
κ_k	20	adjustment cost of capital	[Henriet et al., 2014]
ρ	0.5	Elast. sub. between labor and U	[Henriet et al., 2014]
λ	0.5	Elast. sub. between labor and Z	[Henriet et al., 2014]
ϱ	2.5	Elast. sub. between clean and dirty goods	[Papageorgiou et al., 2017]
η	0.5	Elast. sub. between clean private and public capital	[IMF, 2023a]
ψ	0.5	Elast. sub. between dirty capital and fossil fuels	[Henriet et al., 2014]
Government			
ϕ_b	0.2	sensitivity of transfers to debt deviations	
Open Macro			
σ, β	1.5	Elast. sub. between foreign/domestic intermediate goods	[Annicchiarico & Diluiso, 2019]

Appendix B – Initial steady state

We calibrate to match standard ratios for labor and capital, while incorporating a few non-standard ratios:

- Public capital constitutes 25% of total clean capital.
- Debt levels amount to 80% of GDP.
- The clean sector represents 25% of total production.
- Trade openness is 15%.

Additionally, we capture the dynamic response of the current account to a 1% of GDP shock of government spending, which leads to a -0.2% impact for the Euro Area [Dalsgaard et al., 2001].

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A Holistic Assessment of Carbon Taxation: The case of Denmark

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Background

- Danish climate goals – National and EU
- Agriculture and food production industries estimated to become largest emitters in 2030
- CO_2e tax on production in the Danish agriculture industry – Danish parliament (2024)
- ***We look at a CO_2e tax on final consumption as an alternative***

Consumption vs production taxation – a holistic assessment

Production taxation (pros/cons)

- Administrative burden
- International trade & Carbon leakage
- Technological development
- Final demand substitution effects

Consumption taxation (pros/cons)

- Administrative burden
- International trade & Carbon leakage
- Technological development
- Final demand substitution effects

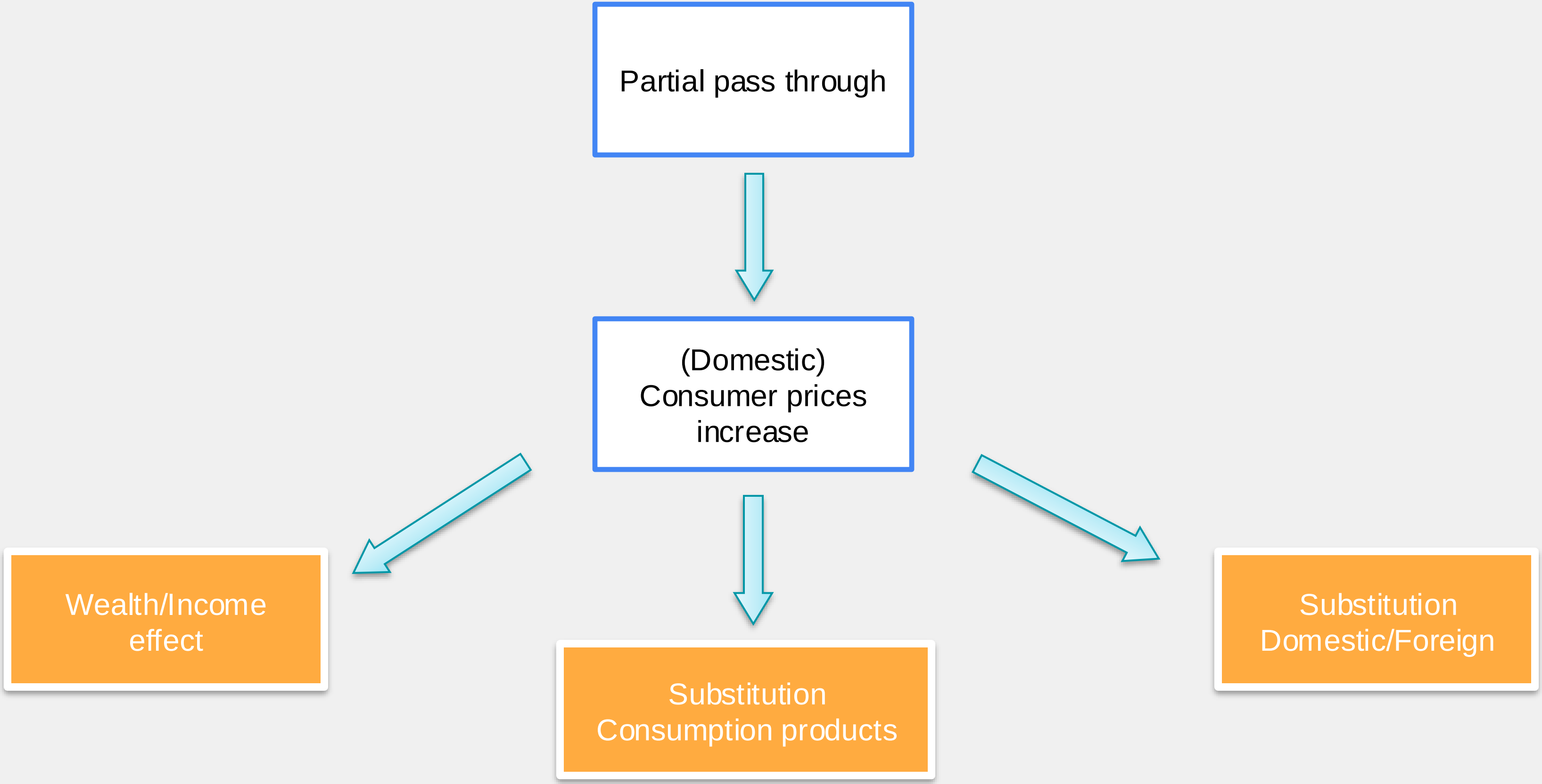
Consumption vs production taxation – Contribution

Environmental effects (CO2e emissions)

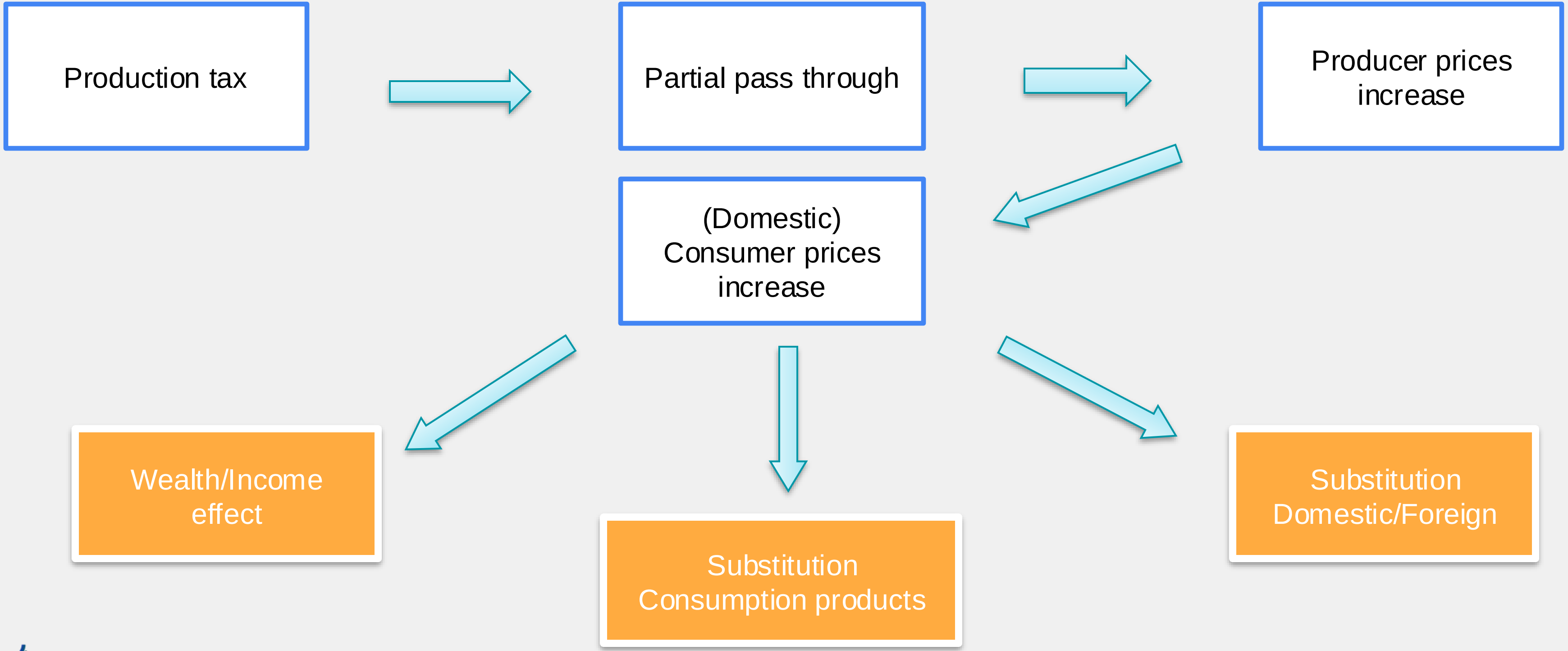
Economic effects (Environmental sacrifice ratio)

Financial effects (Net Financial Wealth)

Model structure - Important dynamics for a consumption tax



Model structure - Important dynamics for a production tax



Scenario analysis

Scenario 1: Consumption tax on household consumption

- **Meat** and **Dairy** products (both domestic and imported)
- Consumers pay 750 DKK (107 USD) per ton CO_2e emitted

Scenario 2: Production tax in the Agricultural industry

- Agriculture pays 387 DKK (55 USD) per ton CO_2e emitted (non-energy related)
- All environmental taxes on energy are removed

In both Scenarios the additional tax revenue is 2.4 billion DKK (0.33 billion USD) at implementation.

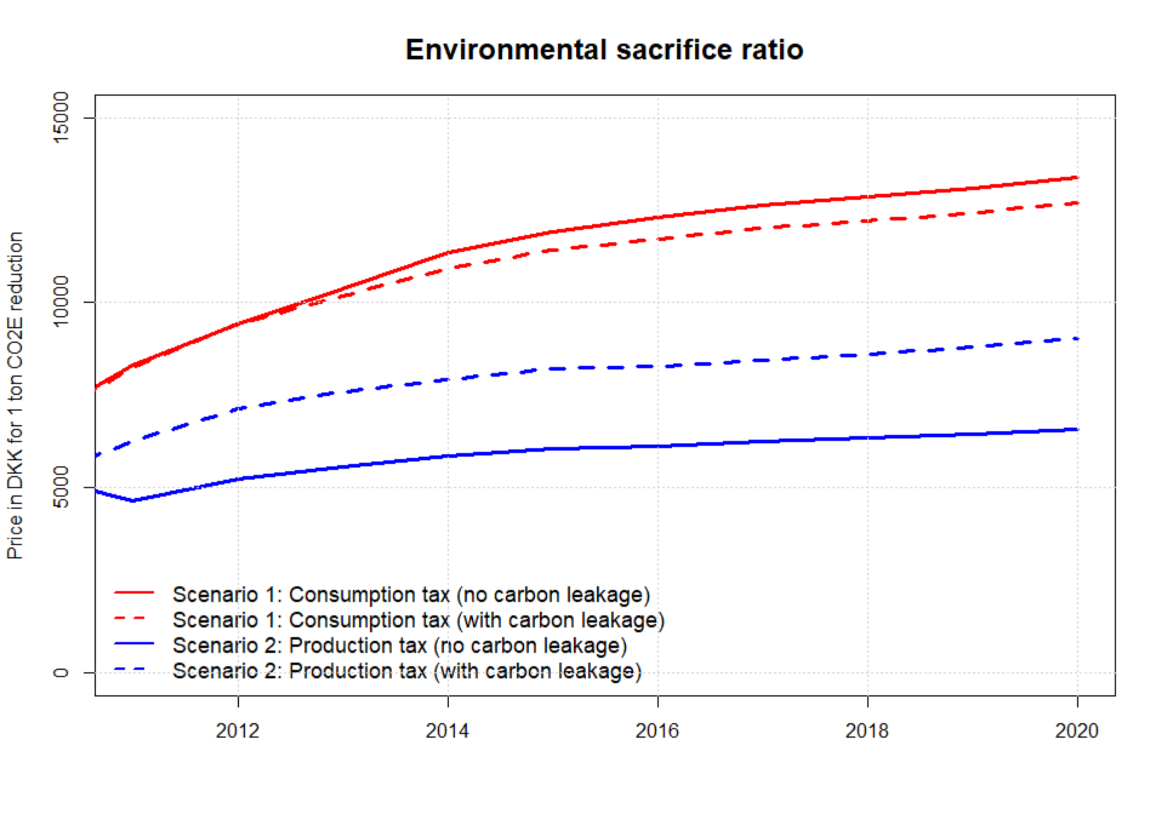
Scenario results:
Environmental sacrifice ratio

Environmental sacrifice ratio:

- $\frac{\textit{Cumulative change GDP}}{\textit{Cumulative change emissions}}$

Carbon leakage:

- Leakage through international trade



Scenario results - Financial net wealth

Production tax

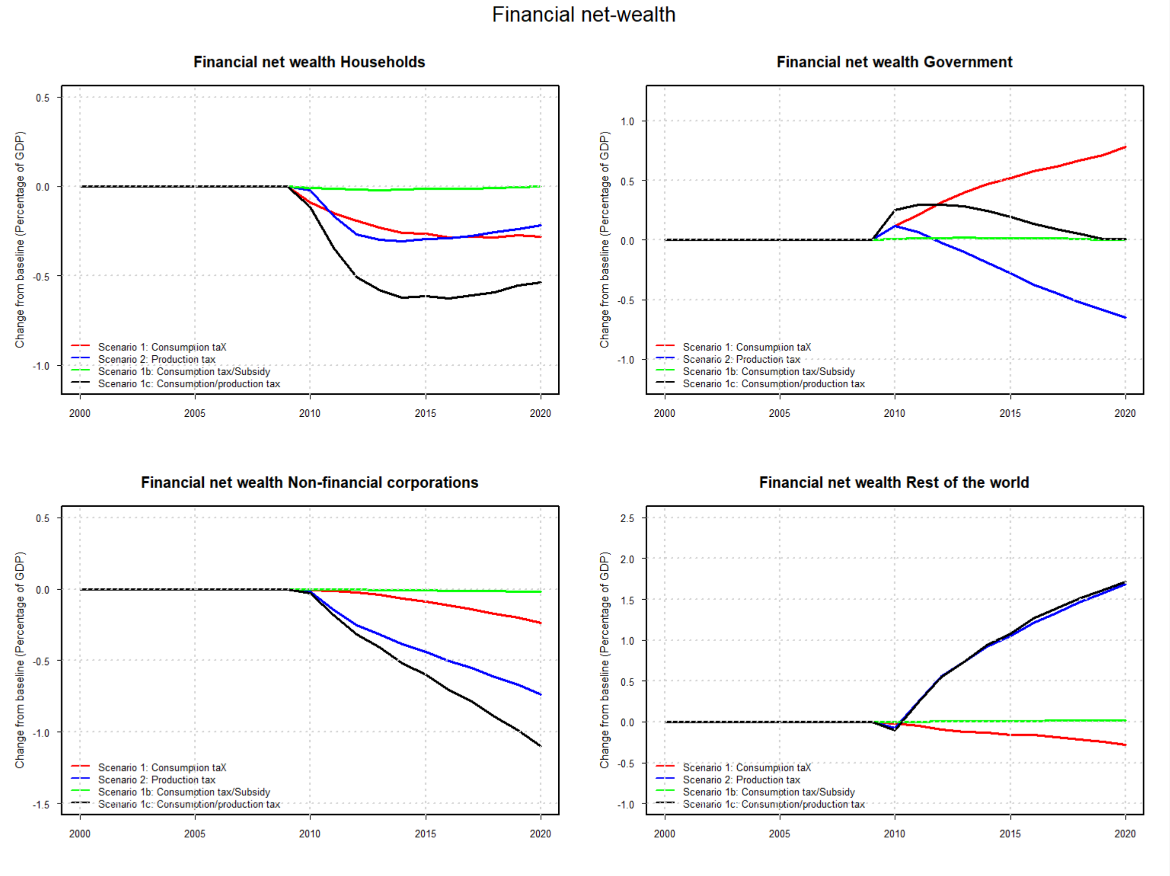
- Financial net wealth accumulates outside the regulated country

Consumption tax

- Financial net wealth accumulates in the government sector – Tax revenues

Tax recycling:

- ***Scenario 1b***: Consumption tax/subsidy
- ***Scenario 1c***: Consumption/production tax



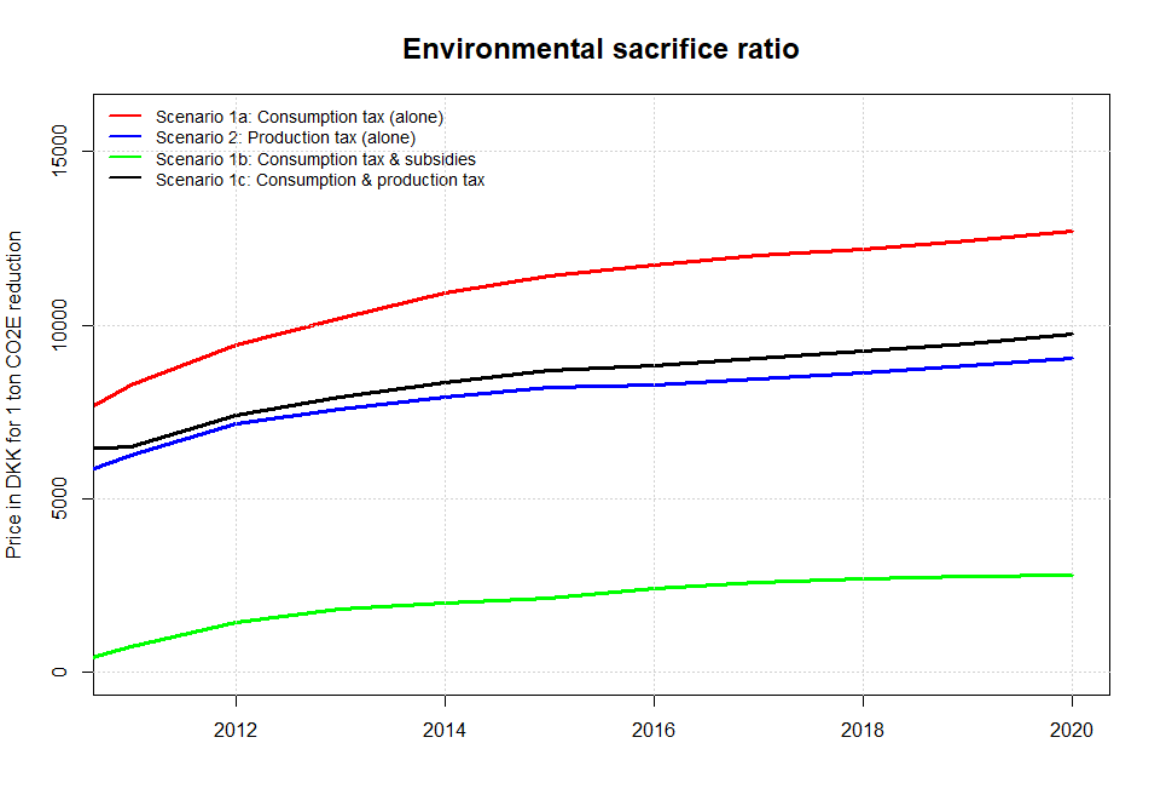
Scenario results – Environmental sacrifice ratio

Consumption tax/subsidy (Green)

- Lowest environmental sacrifice ratio
- Almost no effect on net financial wealth

But what should we keep in mind?

- Low level effect on CO_2e-emissions
- Administrative costs
- Technological change – Relevant for agriculture?



Concluding remarks

- **Consumption tax** improves government financial capacity, enabling additional **climate action**.

- We propose a **combination of consumption taxes and subsidies** – achieving low financial and economic effects **but** with limited environmental impact.

- Balancing environmental, economic, **and financial** outcomes in environmental policy design remains a concern.

Q&A
Discussion

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Thank you

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Appendix - Ecological Stock-Flow-Consistent Input-Output (E-SFC-IO) model for the Danish economy (Thomsen et al. 2024)

5 Sectors: Households, Non-Financial Corporations, Financial Corporations, Government, Rest Of the World

9 Industries: 1.) Agricultural/Forestry/Fishery, 2.) Mining, 3.) Manufacturing of meat products, 4.) Manufacturing of dairy products, 5.) Manufacturing of bread products, 6.) Manufacturing of other food products, 7.) Energy supply, 8.) High energy intensive industries, and 9.) Other industries

7 final consumption goods: Bread, Meat, Fish, Dairy, Fruit and vegetables, other food, and other consumption products

21 types of Energy: Crude oil, Oil products, Electricity, Natural gas …

6 types of emission: Carbon dioxide (CO_2), Nitrous oxide (N_2O), Methane (CH_4), Sulphur hexafluoride (SF_6), Perfluorocarbons (PFC), Hydrofluorocarbons (HFC)

8 types of financial assets: Gold, Deposits, Securities, Loans, Equities, Insurance, Financial derivatives, and Trade credits

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Research Segment

Carbon taxation, implementation and impacts

Hélia Costa (OECD) & Ornella Torres (WB/C3A, PSE, Ponts ParisTech)

10:00am-11:30am Conference Room B

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Who pays for higher carbon prices? Mitigating climate change and adverse distributional effects

Cathal O'Donoghue (University of Galway)

Drawing on joint work with Herwig Immervoll (OECD); Anasuya Raj (OECD); Assia Elgouacem (OECD); Jules Linden (University of Galway, LISER);Denisa Sologon (LISER) Zeynep Gizem Can (Adana Alparslan Türkeş Science and Technology University)

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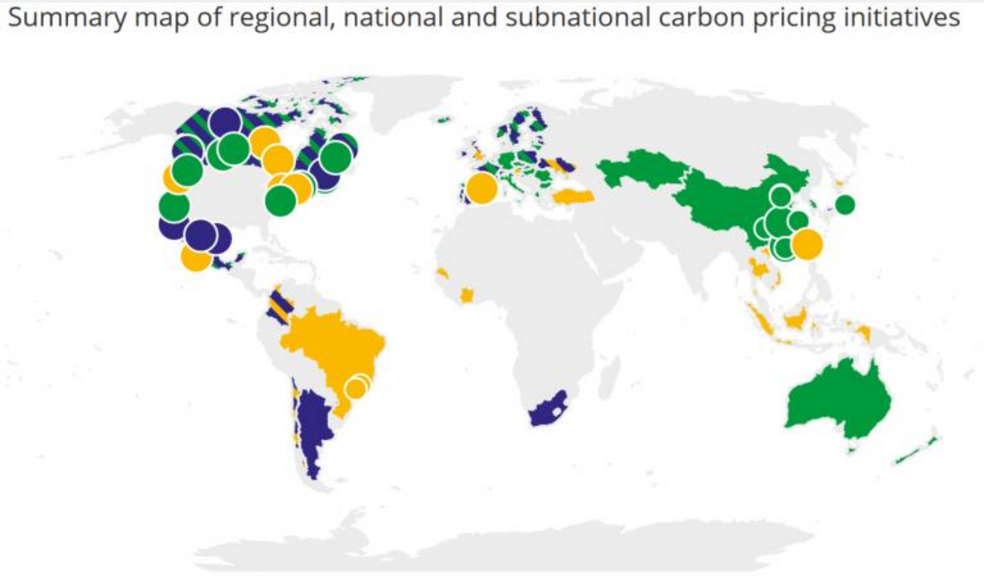
Carbon tax/pricing under development

- **Many OECD and a few Middle Income countries have or are considering the use of Carbon tax/ pricing**
- **Pro-poor Environmental Policy - Pricing carbon will involve fewer social, economic and environmental trade-offs** if it is accompanied by measures that ensure **affordable access to cleaner alternatives**.

Carbon tax/pricing under development



Green: ETS implemented or scheduled
Yellow: Considered an ETS or carbon tax
Blue: Carbon tax implemented or scheduled
Green / Yellow : ETS implemented, carbon tax under consideration
Blue: Yellow : Carbon tax implemented or scheduled, ETS considered

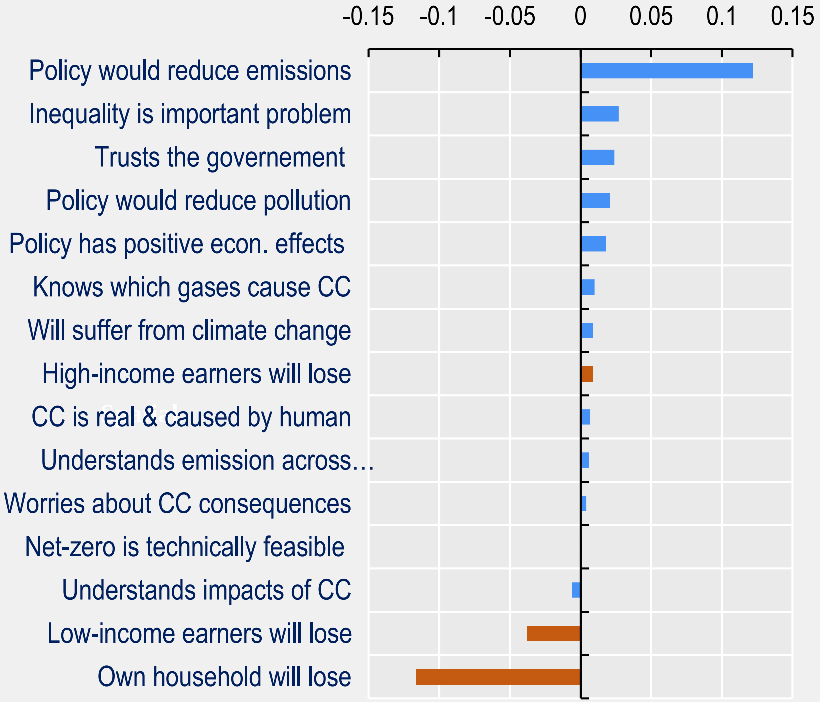
Source https://www.ciat.org/ciatblog-taller-de-la-onu-sobre-impuestos-al-carbono-parte-1-en-paises-en-desarrollo/?lang=en

Climate change mitigation: Green and fair?

- Distributional effects of climate policies: Numerous channels, different speeds
- Of immediate interest in current policy context:
- How do higher carbon prices affect livelihoods of households?
- What are policy options for alleviating burdens on specific population groups?
- Can there be a “double dividend” of lower emissions and reduced inequality?

Support for climate policies hinges on perceived gains & losses

Correlation between beliefs & support for carbon tax package



Note: n=40 680, R^2=0.378. 20 OECD and non-OECD countries, accounting for 72% of global CO_2 emissions
Source: Dechezleprêtre et al (2022), ”Fighting climate change: International attitudes towards climate policies”

Source https://www.ciat.org/ciatblog-taller-de-la-onu-sobre-impuestos-al-carbono-parte-1-en-paises-en-desarrollo/?lang=en

Theoretical Issues – Carbon Pricing

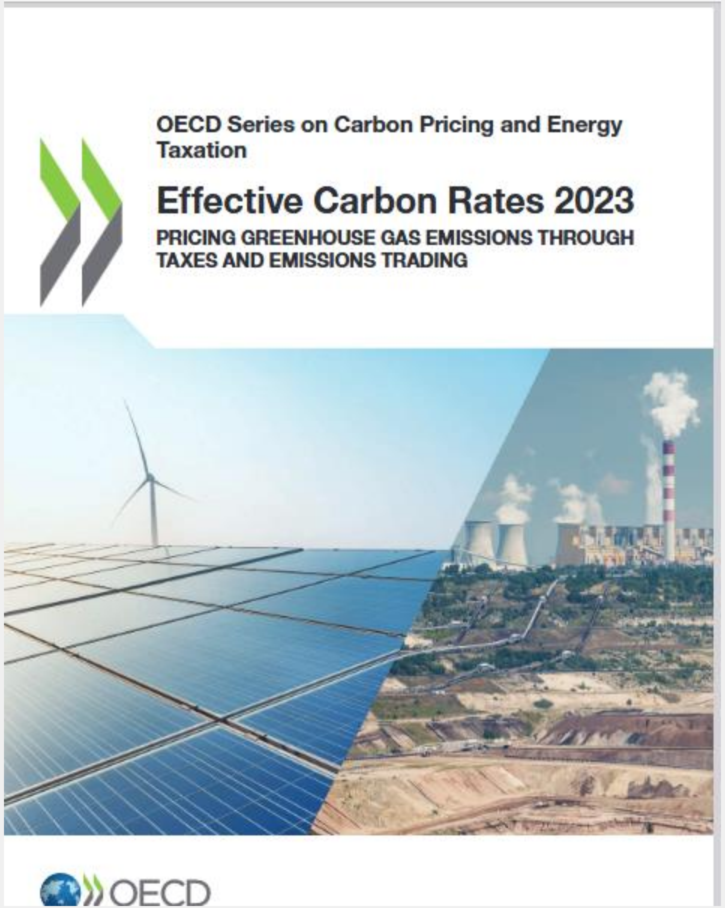
- **Nature of emissions** consumed
  - Type of **fuel consumption**
  - Type of **food** consumption
  - Construction use and other direct and indirect sources of emissions
- **Location of greenhouse gas emissions** across the **income distribution**
- **Price and influence of tax** on existing fuels and interaction with other instruments
  - **Heating fuels** typically have lower taxation and/or higher subsidies
  - **Heating fuels** sometimes have **higher emissions** (solid fuels)
  - Poor often more likely to spend on **heating fuels**
  - **Own produced consumption in developing countries – firewood – hard to reach with policy**

Theoretical Issues – Carbon Pricing

- Short-term and Long-term price **elasticity Issues**
  - **Capacity to invest** in cheaper energy rather than just **reduce emissions – fuel poverty**
- **Use of Revenue** often most **important distributional impact**
- **Double Dividend Replacement of more distortionary taxation** can improve **efficiency** – however **difficult to minimise both** distributional impact <u>and</u> reduce distortions

CONTEXT

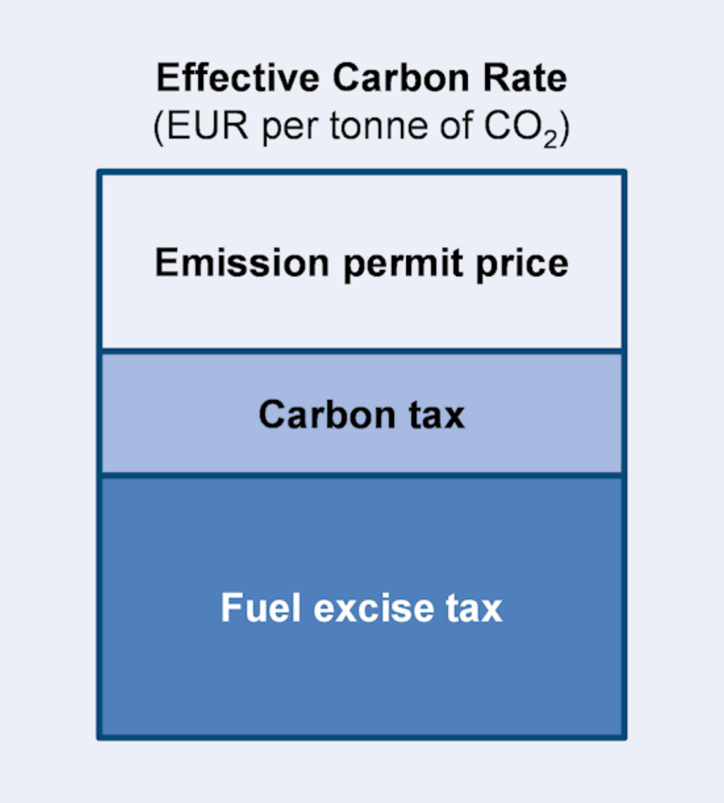
- OECD produce an analysis of Effective Carbon Rates every three years
- “Carbon pricing very effectively encourages the shift of production and consumption choices towards low and zero carbon options that is required to limit climate change.
- The "carbon pricing score" measures how close the 44 countries, together as well as individually, are to the goal of pricing all energy related carbon emissions at current and forward-looking benchmark values for carbon costs.”



Types of Carbon Price

- Different Sources of Carbon Prices
  - Emissions Trading
  - Carbon Taxes
  - Fuel Excise Tax

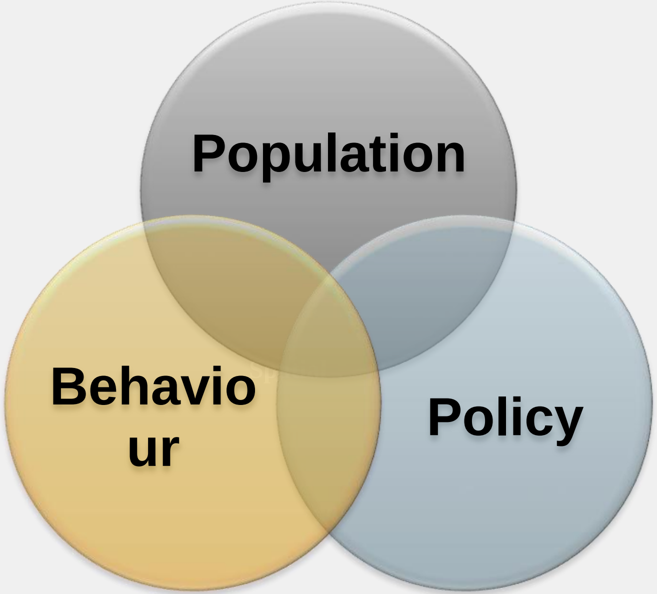
- Also indirectly VAT as these instruments are typically vateable

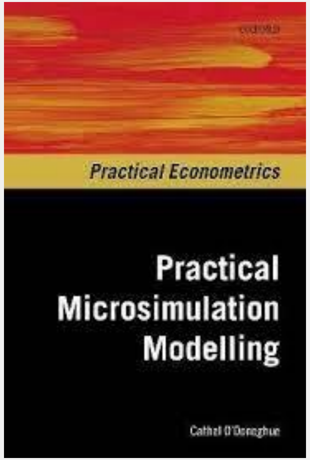


Method - Microsimulation

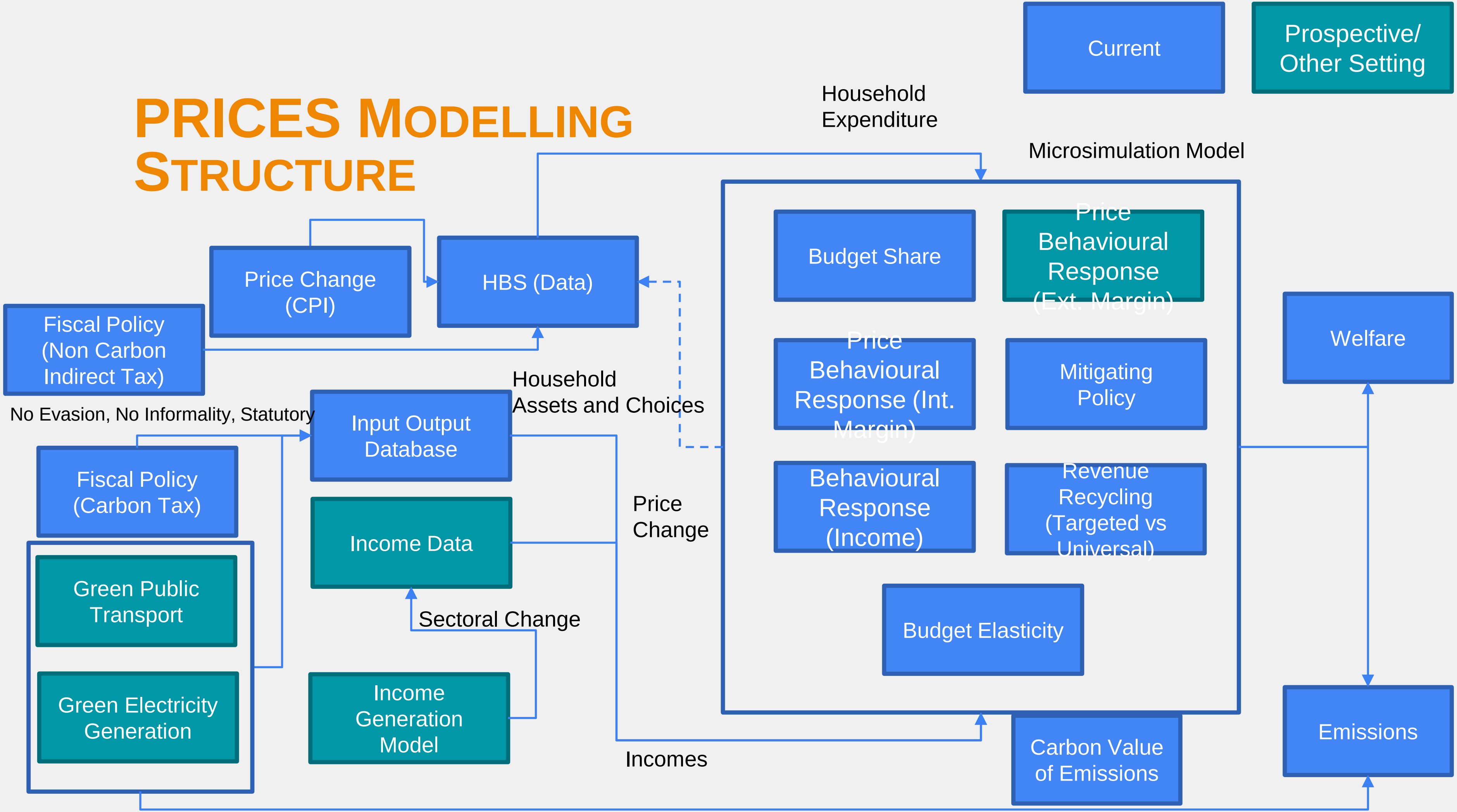
- Study Impact of Public Policy
  - Effectiveness of Existing Policy
  - Evaluate potential reform
- Micro-Simulation
  - Analysis at Micro Level
  - Ex Ante Simulate Policy
- Helps in Understanding Complexity
  - Policy x Population
  - Micro → Complexity → Improve Design of Policy

Core Purpose of Microsimulation Models
Understand and Manage Complexity





PRICES MODELLING STRUCTURE

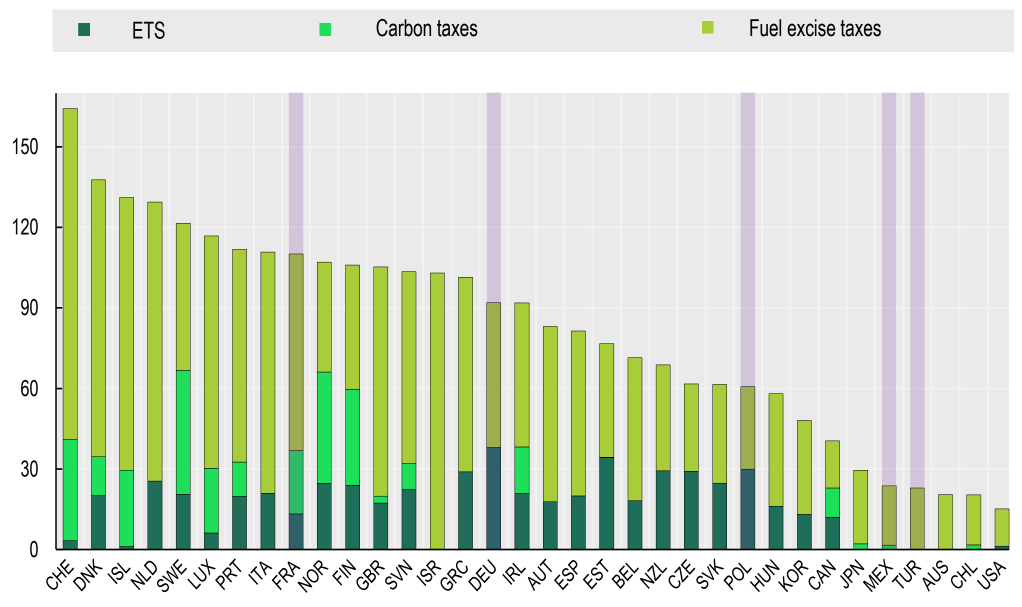


Pricing carbon emissions

Considerable scope / need for higher carbon charges

- Increasing political traction of carbon pricing
  - Globally > 70 explicit pricing initiatives
  - 3-7% GHG reduction for EUR 10 / tCO_2e
- But current national & internat. mitigation commitments are nowhere near sufficient
  - to stay below +1.5 °C, 2030 emissions need to fall by 42%
  - < ½ of GHG were priced in 2021, speed of adoption varies, big & growing gaps between countries with high & low prices
  - Current prices can be an order of magnitude below those that are compatible with longer-term climate commitments / aspirations
- Need transformative step changes combining multiple policy levers
  - Supply & demand, price & non-price
  - Each has distributional consequences

Effective carbon rates in 34 OECD countries, 2021
In EUR / t CO_2



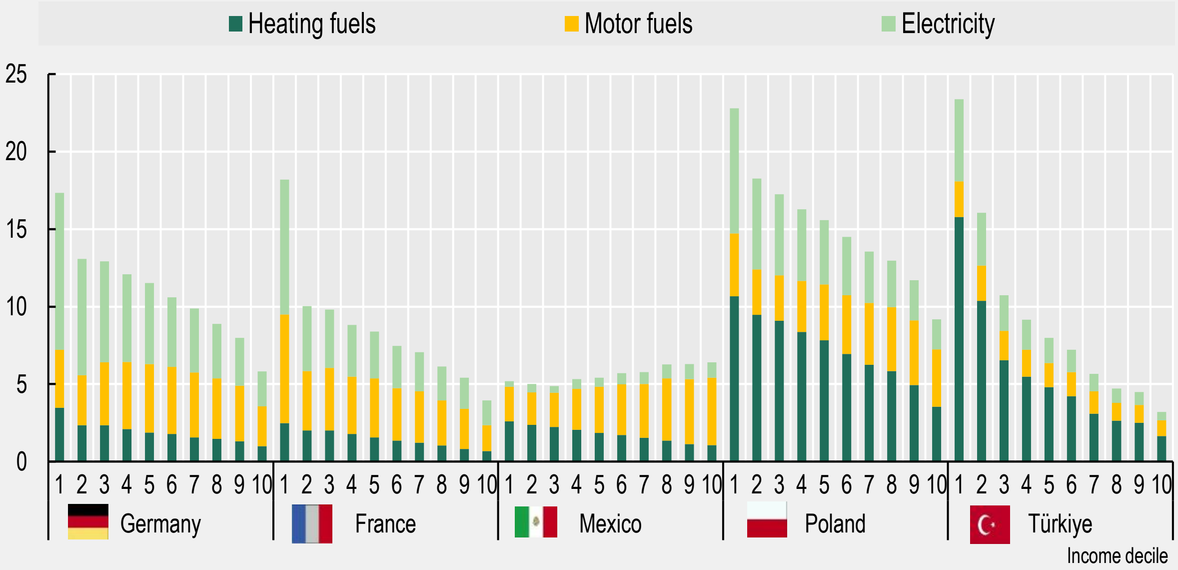
Source: https://doi.org/10.1787/9138d7e3-en

Parts of people's energy use relate to basic needs

But not all fuel spending is regressive

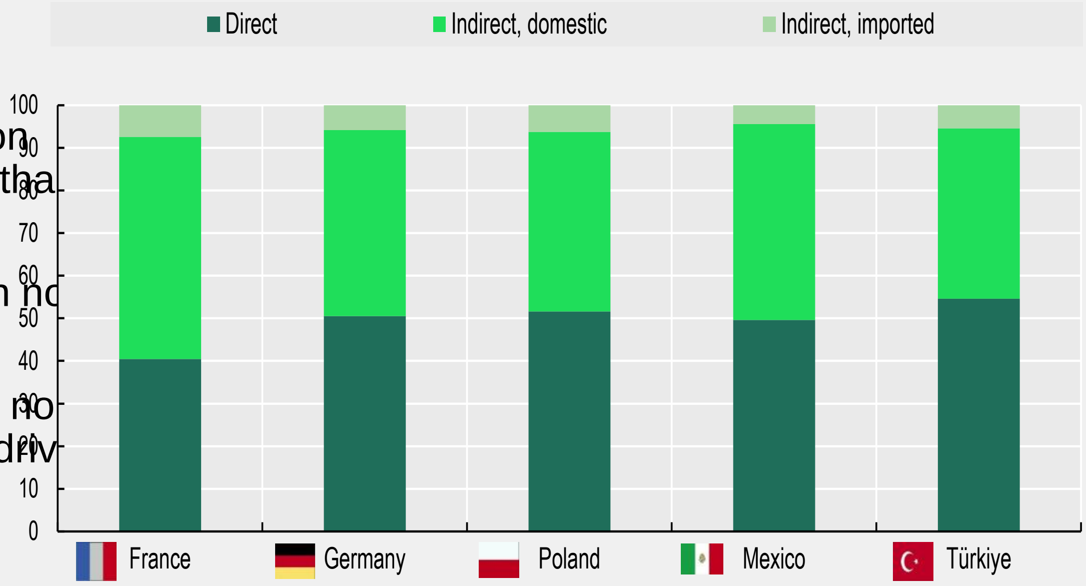
- Lower-income households consume larger parts of their income on heating
  - They are also more likely to use cheaper and "dirtier" fuel
- But spending on motor fuel, and resulting carbon-tax burdens, are very "top heavy"
- Electricity: Impact of carbon prices on households is less clear
  - Spending levels vary a lot
  - So does carbon intensity of electricity generation (POL 15x more than FRA)

Household expenditures on fuel and other energy
% of disposable income, by income decile



Households' carbon footprints
Fossil fuel consumption is important, but so is other spending

Emissions from fuel ("direct") and non-fuel ("indirect") consumption
In % of total emissions



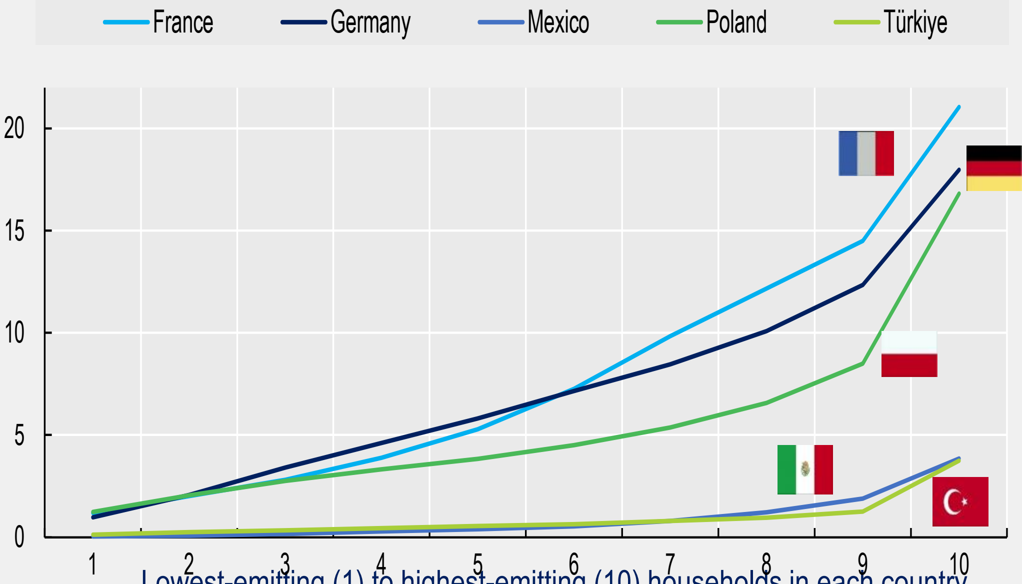
- Per unit of spending, fuel consumption creates significantly more emissions tha spending "on everything else"
- But households spend much more on no fuel items than on fuel
- Emissions linked to the production of no fuel items are therefore a significant driv household footprints

Source: https://doi.org/10.1787/9138d7e3-en

Very unequal carbon footprints
Both across and within countries

- Many factors drive country differences: level of development, population density, consumption patterns, production technology
- Average household emissions range from 1 tonne (MEX, TUR) to 8-9 (DEU, FRA)
- Consumption of top 10% emitting households in MEX & TUR produced the same emissions as 3rd decile in DEU

Carbon footprints per household
In t CO_2



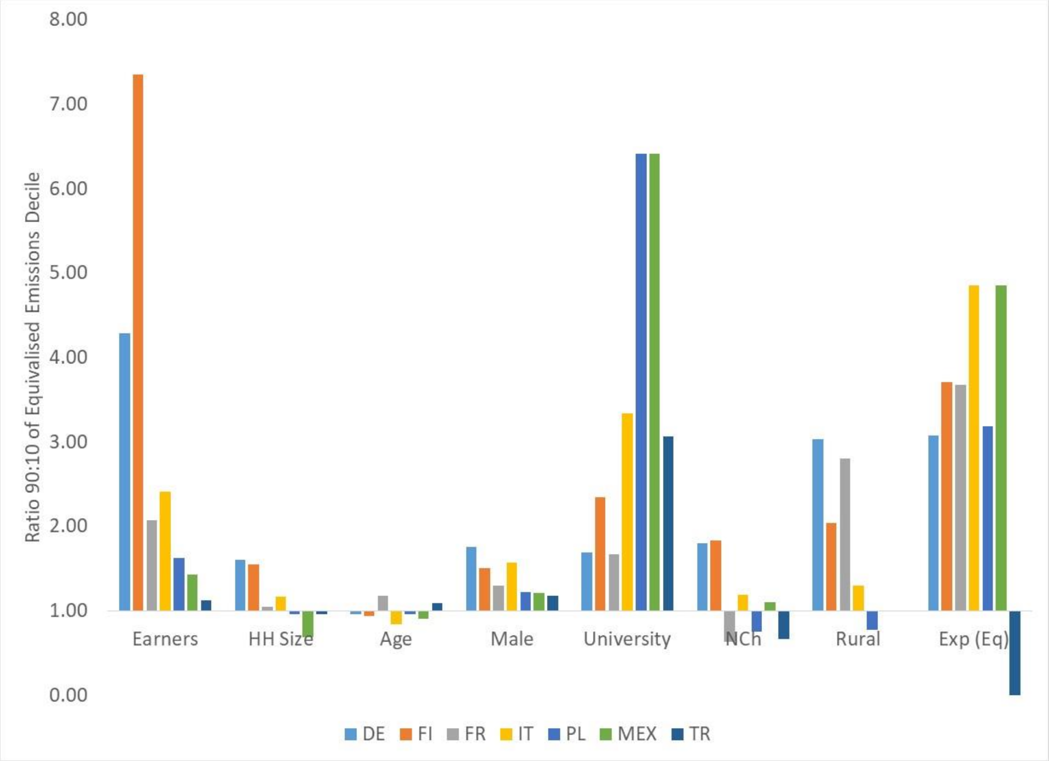
Lowest-emitting (1) to highest-emitting (10) households in each country
(emissions decile groups)

Source: https://doi.org/10.1787/9138d7e3-en

HOUSEHOLD CHARACTERISTICS

- Important differences between household types
- However Differences not constant across countries
- EU – Earnings, Expenditure, gender, children rural
- Non-EU University
- Age relatively unimportant, but being a pensioner important – however lower income dominates

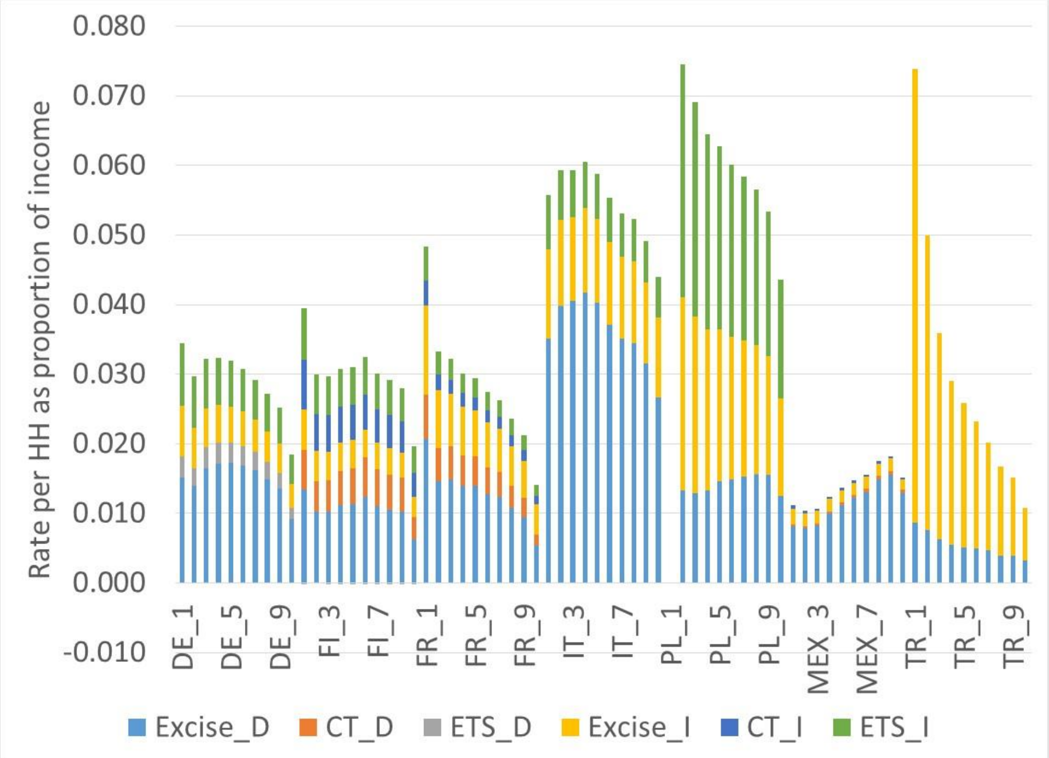
Household Characteristics **(ranked by equivalised emissions) 90:10 Decile Ratio**



DISTRIBUTION OF CARBON PRICE INSTRUMENTS

Carbon Price Instruments as ratio of income **(ranked by income decile)**

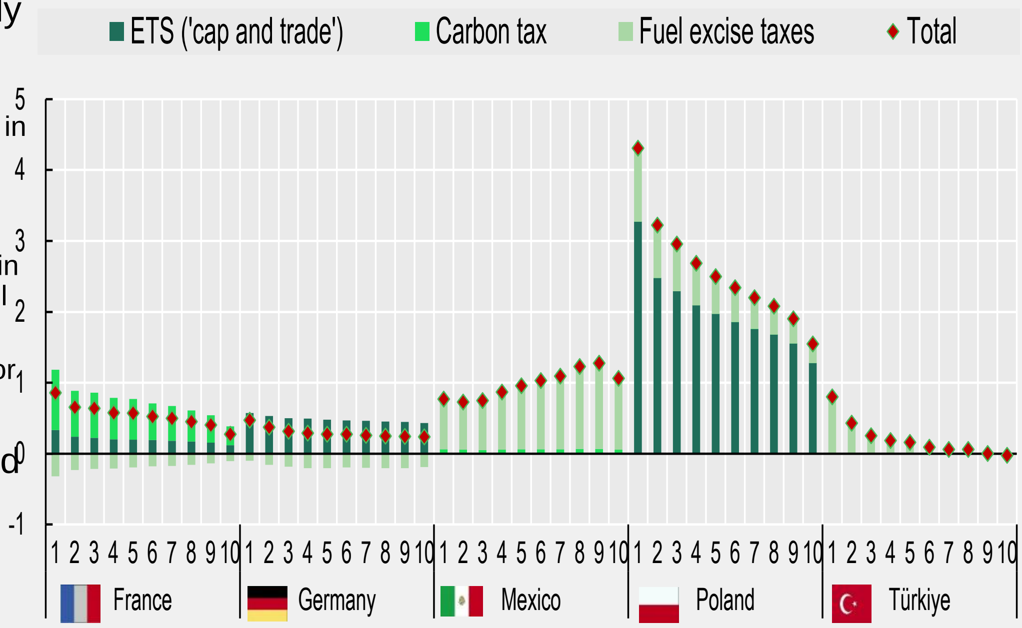
- Carbon Price Instruments divided into
  - 3 Instruments Excise Duties, Carbon Taxes, ETS
  - 2 Dimensions – Direct Energy Use; Energy used in other goods and services
- 2021
  - Generally declining as share of income, but relatively flat as share of expenditure
  - Importance of Savings
  - Excise Duties (both direct and indirect generally the most important)
  - ETS relatively important in Poland



A decade of carbon-pricing measures
Big burdens for households?

- Real-world carbon charges do not apply uniformly so emissions not priced equally
  - Highest rates in road transport sector, followed by electricity and off-road transport. Majority of emissions in industry (72%), building (64%) remain unpriced
- 2012-2021: Considerable policy innovation
  - ETS prices & coverage ▲ across EU, excise taxes ▲ in MEX, new carbon tax in FRA, carbon prices in TUR fell by 80% in EUR terms but increased in nat. currency
  - Multiple concurrent or sequential reforms can amplify or offset each other
- Average burdens were muted over the period and much lower than recent inflation
- But they were significant for some groups
  - Poor & (lower) middle class; dual earners (DEU); rural (DEU, FRA), pensioners (MEX)

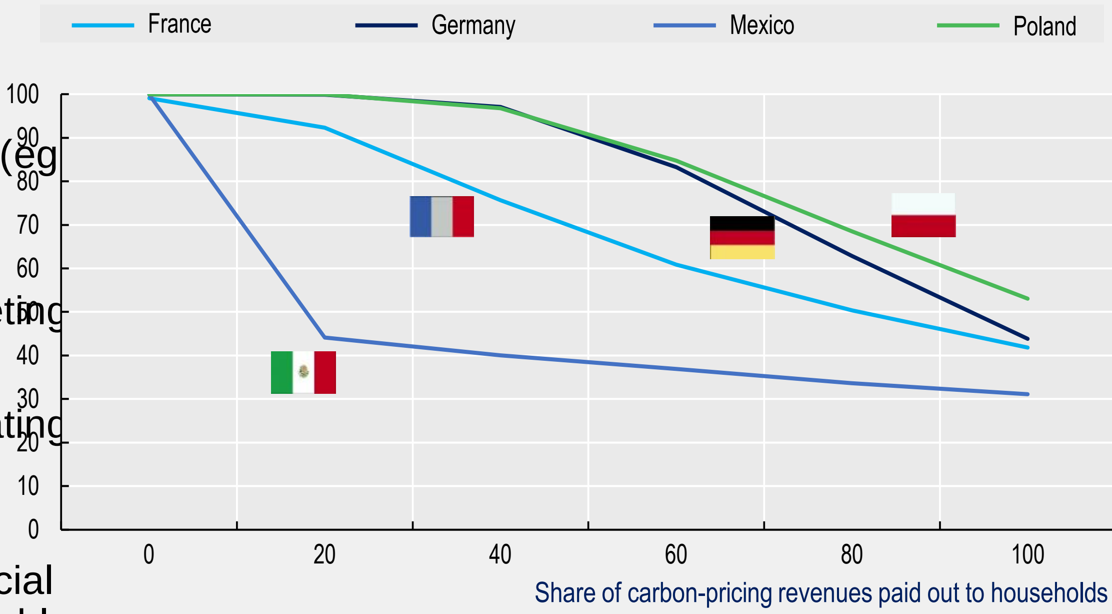
Average annual burdens
In % of income, 2012-2021



Carbon pricing with revenue recycling
‘Gainers and losers’, fiscal cost

- Governments can use carbon-pricing revenues to finance cash transfers that soften detrimental distributional effects
- Only some countries directly "recycle" revenues back to households in this way (eg Austria).
- In the near future, deteriorating fiscal outlooks are likely to translate into competing demands on carbon-pricing revenues
- This may reduce the scope for compensating households
- Need cost-effective compensation, in coordination with existing support and social protection programmes that may be available to affected groups

Partial revenue recycling: Lump-sum transfers
Share of individuals with net losses, by share of revenues paid out



Source: https://doi.org/10.1787/9138d7e3-en

Conclusions and Take Home Message

- When done well, carbon pricing reduces emissions in “invisible hand” type fashion. But at levels needed for meeting climate commitments, impact on households anything but invisible
- Without carefully tailored compensation for households, reforms unlikely to be seen as inclusive. May meet stiff resistance, especially when prices increase quickly / unpredictably
- Distributional Impact: Differences across countries
  - Difference in budget shares of fuel expenditures across countries
  - Generally declining budget shares as percentage of income
  - Mainly regressive carbon prices →Quite different strategies in terms of instruments
  - Substitution of existing revenue – reduces capacity for mitigation
- Mitigation
  - Hard to achieve both reductions in distortions and to protect losers
  - Revenue recycling differs across countries, → population structure along income distribution

Conclusions and Take Home Message

- Climate Justice challenges
  - Not only between OECD citizens within OECD countries, but between OECD countries
- Many policy levers: How to deploy / sequence them?
  - Maximise impact on emissions while highlighting barriers to political feasibility
  - Actionable results to inform targeting strategies, including for support programmes that tackle households' underinvestment in energy efficiency
  - Scenarios for different reform options
  - Non-energy related emissions: Food production
  - Widen country coverage. Regular update to account for evolving policy agenda, consumption patterns, preferences
- Ways to join forces across IOs for consistent & co-ordinated distributional assessments
- Quite a number of modelling choices → Session – International Microsimulation Association June 2025