Should carbon pricing be different across countries?

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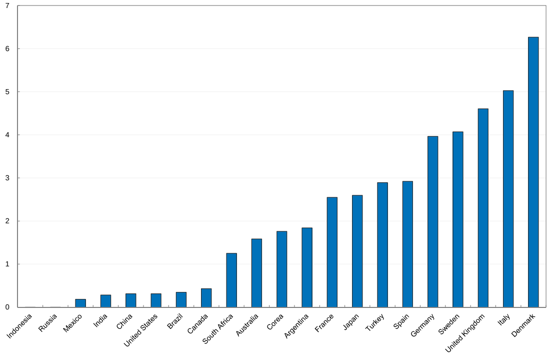
Outline of the talk

- Energy taxes: Facts and data
- Research question: Should the carbon price be the same in all countries?
- Model
- First, second and third bests: results
- Illustration in the two country case
- Conclusion

Energy taxes: Facts and data

Economy-wide average effective tax rates on energy in selected countries (€/GJ) – Source: Taxing Energy Use 2015, OECD



Taxes are very different across countries

		Oil products	Coal and peat	Natural gas	Biofuels and waste	Renewables and nuclear	All fuels
	% of base	27%	34%	20%	9%	11%	100%
Transport use	18	5.20	0.00	0.12	3.74	0.00	4.96
Heating and process use	42	0.82	0.05	0.21	0.00	0.00	0.26
Electricity production	40	0.50	0.13	0.43	0.65	0.38	0.27
Total use	100	3.52	0.10	0.28	0.30	0.38	1.11

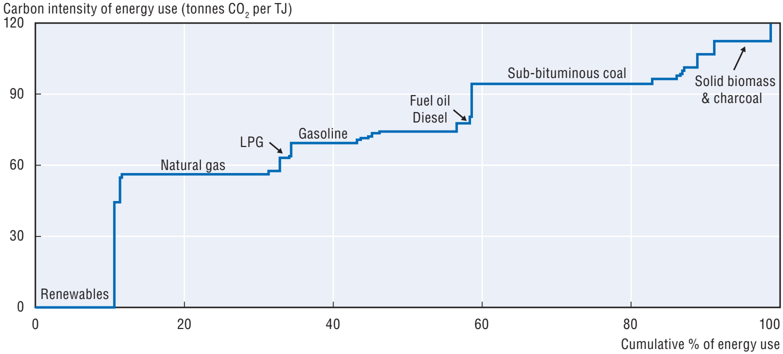
Source: Energy Use 2015: OECD and Selected Partner Economies, OECD

41 countries: 34 OECD countries, plus Argentina, Brazil, China, India, Indonesia, Russia and South Africa

Table: Weighted average effective tax rates on energy by fuel type and use (€/GJ), 41 countries

Taxes are very different across products and uses
What is actually taxed: oil for transport
Coal is almost not taxed

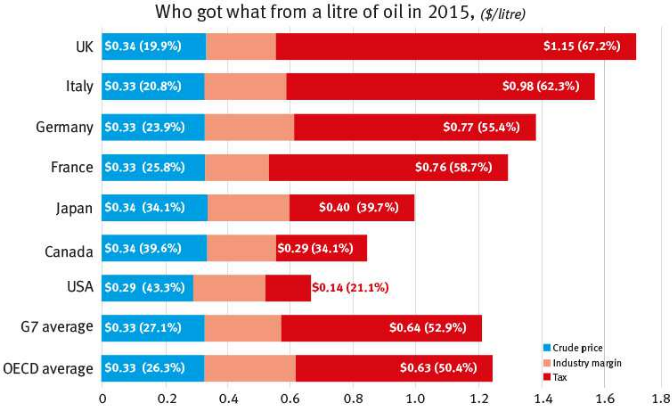
Figure 4. **Carbon intensity and amount of energy use by different fuels across all 41 countries**



Source: Taxing Energy Use 2015, OECD

OPEC : Taxes on Oil

Organization of the Petroleum Exporting Countries



The graph above illustrates the inter-country variations in the average price of one litre of oil across G7 countries as well as the OECD average during 2015. It is important to note that these price variations are mainly due to the widely varying levels of taxes (highlighted in red) imposed by major oil consuming nations. These can range from relatively modest levels - like in the USA - to very high levels in Europe and Asia/Pacific.

Why do/should we tax energy?

- to finance public spending (well known debate about direct vs indirect taxation);
- to internalize negative externalities (pigouvian taxation)
  - local: local pollution, congestion, infrastructure use
  - global: climate change

Financing motive: countries tend to tax imported energy, to reap a part of the scarcity rent of fossil energy in producing countries.

Pigouvian taxation is (almost) everywhere underdeveloped (as far as we can say – the measure of external effects is very approximate). When it exists, it is mostly designed to internalize local externalities.

However, taxing carbon to curb emissions and fight climate change is an urgent and pressing issue.

Argument

- Virtues of a uniform carbon tax well known.
  - Standard theory
  - New arguments. See *Economics of Energy & Environmental Policy*, Symposium on International Climate Negotiations, 2015
- But uniform carbon tax not implemented. Not even mentioned in COP21 agreement.
- Standard theory argument: first best setting + no other taxes.
- Reality:
  - big differences across countries, fuels and uses in initial energy taxation. Should we super-impose the same carbon tax everywhere? Knowing that taxes on energy intended to curb local externalities or finance public spending do a part of the job of the carbon tax.
  - big differences across countries in purchasing power. Can equity concerns lead to accept different carbon taxes?
  - different historical responsibilities
  - not first best

Model

A. d'Autume, C. Withagen and K. Schubert, Should the carbon price be the same in all countries? JPET 2016

- Very simple static model
- n countries which interact through global emissions only
- Inter-country transfers feasible
- One representative consumer per country (no intra-country redistribution issues)
- 3 goods: C private and non-polluting; X private and polluting; G public and non-polluting
- Emissions of country i: $Z_i = X_i$
- World emissions: $Z_w = \sum_{i=1}^{n} Z_i$
- Utility function of the representative consumer in country i :

$$U^i(C_i, X_i, G_i, Z_i, Z_w)$$

- No strategic behaviors

First best

World social planner maximizes a weighted sum of utilities, with weight β_i for country/consumer i, subject to the resource constraint.

Optimality conditions:

- weighted marginal utilities from clean consumption equalized across countries

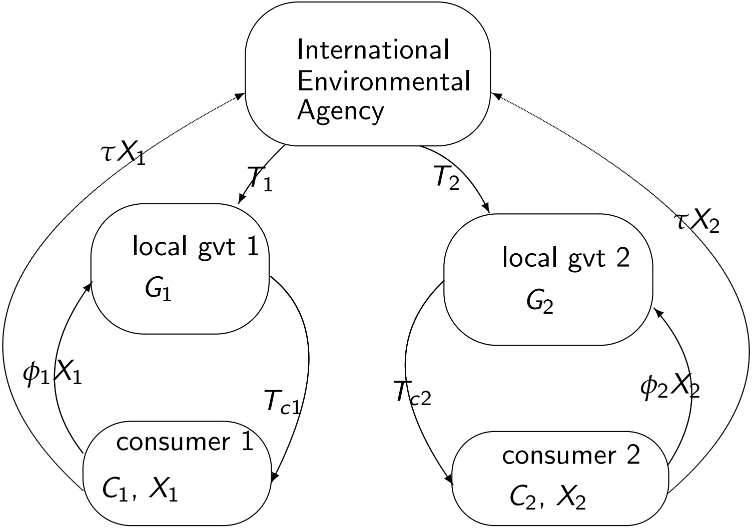
$$\beta_1 U_C^1 = ... = \beta_i U_C^i = ... = \beta_n U_C^n$$

- marginal rate of substitution between the 3 goods equal to their relative production costs (here, $= 1$)

$$\frac{U_G^i}{U_C^i} = 1, \quad i = 1, ..., n$$

$$\frac{U_X^i}{U_C^i} + \frac{U_Z^i}{U_C^i} + \sum_{j=1}^{n} \frac{U_{Z_w}^j}{U_C^j} = 1, \quad i = 1, ..., n$$

Decentralization first best



- Tax rate paid by consumer i = local component + common global component:

$$\theta_i = \phi_i + \tau, \quad \phi_i = -\frac{U^i_Z}{U^i_C}, \quad \tau = -\sum_{j=1}^{n} \frac{U^j_{Z_w}}{U^j_C}$$

  Pigouvian taxes.
- Local government i makes direct positive or negative transfers T_{ci} to consumers.
- Transfers from the International Environmental Agency to local gvt i: T_i. May be $>$, $=$ or $<$ τX_i. Depends on the βs but also on the characteristics of preferences.

Second best

- Governments unable to finance public good provision through lump-sum taxation of consumers must resort to distortionary taxation.
  Ramsey optimal taxation approach.
  With externalities: Sandmo 1975.
- New constraint: $T_{ci} \geq 0, \quad i = 1, ..., n.$
- Second best principle leads to expect a non-uniform carbon tax: first best rules are usually not part of a second best optimal policy (Lipsey and Lancaster 1956-7)

- μ_i : cost of public funds in country i = cost of being unable to levy a lump-sum tax on consumer i.
- Standard Ramsey model:
  - main determinant of the cost of public funds = price elasticity of demand for the taxed good.
  - High elasticity $\Longrightarrow$ high tax rates necessary to obtain a given amount of funds$\Longrightarrow$ activity reduced, high cost of public funds.
- With externalities: the cost of public funds is reduced.
  Double dividend: emissions taxes decrease pollution and provide the regulator with funds, alleviating the cost of obtaining funds.
  Here, the cost of public funds can even become 0 if emissions tax receipts are sufficient to finance public spending.

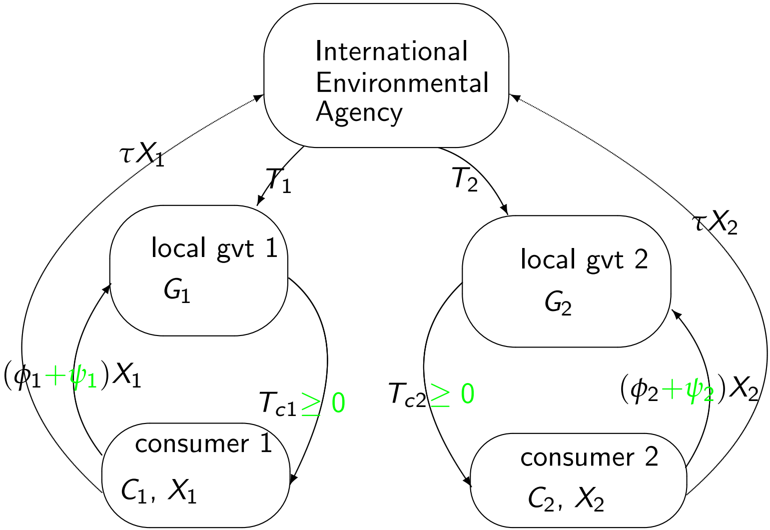
Optimality conditions (Hs are complex interaction terms depending on second order derivatives of the utility function):

$$\beta_1(U_C^1 + \mu_1 H_C^1) = ... = \beta_n(U_C^n + \mu_n H_C^n)$$

$$\frac{U_G^i + \mu_i H_G^i}{U_C^i + \mu_i H_C^i} = 1, \quad i = 1, ..., n$$

$$\frac{U_X^i + \mu_i H_X^i}{U_C^i + \mu_i H_C^i} + \frac{U_Z^i + \mu_i H_Z^i}{U_C^i + \mu_i H_C^i} + \sum_{j=1}^{n} \frac{U_{Z_w}^j + \mu_j H_{Z_w}^j}{U_C^j + \mu_j H_C^j} = 1, \quad i = 1, ..., n$$

Decentralization second best



- The carbon tax is still uniform.
- The overall tax on the polluting good is decomposed in 2 country-specific local taxes + the carbon tax:

$$\theta_i = \phi_i + \psi_i + \tau$$

with

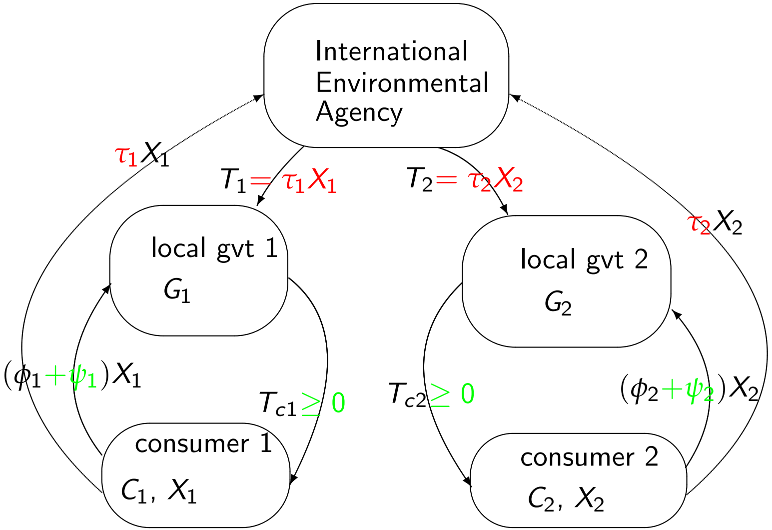
$$\phi_i = -\frac{1 + \mu_i H_Z^i}{1 + \mu_i + \mu_i H_C^i} \frac{U_Z^i}{U_C^i}, \qquad \psi_i = \mu_i \frac{H_C^i - H_X^i}{1 + \mu_i + \mu_i H_C^i} \frac{U_X^i}{U_C^i}$$

$$\tau = -\sum_{j=1}^{n} \frac{1 + \mu_j H_{X_w}^j}{1 + \mu_j + \mu_j H_C^j} \frac{U_{Z_w}^j}{U_C^j}$$

Third best

- For political economy reasons, local governments may not be ready to accept a smaller transfer than the amount of carbon taxes they are paying to the International Environmental Agency.
  Chichilnisky and Heal 1994, Shiell 2003
- Third best: each local government receives a positive transfer from the International Energy Agency equal to the amount of carbon tax it has paid. No other inter-country transfers.

Decentralization third best



- The carbon tax is not uniform anymore.
- Overall tax on the polluting good in country i:

$$\theta_i = \phi_i + \psi_i + \tau_i$$

with

$$\tau_i = -\frac{\sum_{j=1}^{n} \beta_j \left(1 + \mu_j H^j_{X_w}\right) U^j_{Z_w}}{\beta_i \left(1 + \mu_i + \mu_i H^i_C\right) U^i_C}$$

- (The formula of) Pigouvian and Ramsey tax rates ϕ_i and ψ_i are the same as at the second best.
- Carbon tax τ_i is now country-specific.

- Weighted carbon prices are equalized worldwide

$$\beta_1(1+\mu_1+\mu_1 H_C^1)U_C^1\tau_i = ... = \beta_n(1+\mu_n+\mu_n H_C^n)U_C^n\tau_n$$

- Suppose social weights β_i reflect the world regulator's aversion to inequality. Poor country:
  - high β
  - high marginal utility of consumption
  - high cost of public funds
  - $\implies$ high $1+\mu+\mu H_C$ coefficient
  - $\implies$ low carbon tax.
- Generalization of Chichilnisky and Heal (1994)'s result.

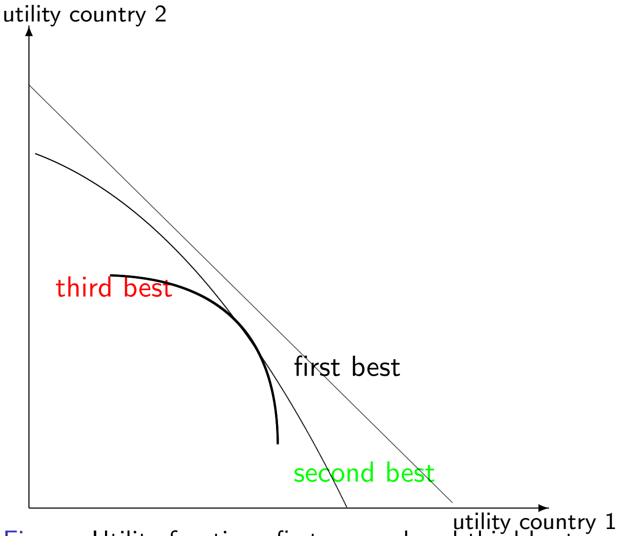


Figure: Utility frontiers, first, second and third best

Illustration in the two country case

Utility functions separable, linear in C, iso-elastic in G and X. Local and global damages also iso-elastic.

Identical countries, same βs

Efficient equilibrium								
	X_i	G_i	T_{ci}	ϕ_i	τ	θ_i	T_i	μ_i
BAU	36.4	20	-13	0.191	0	0.191	0	0
carbon tax	28.6	20	-7	0.085	0.372	0.457	10.6	0
Second best								
	X_i	G_i	ψ_i	ϕ_i	τ	θ_i	T_i	μ_i
BAU	29.1	12.7	0.376	0.062	0	0.438	0	0.46
carbon tax	27	14.2	0.314	0.053	0.160	0.527	4.3	0.33

Comparison of BAU and simulation with carbon tax

- Local taxes ϕ_i must be reduced when the carbon tax is introduced.
- Total taxes θ_i with than without carbon tax, as now more externalities are internalized $\Longrightarrow X_i$ decreases.
- With carbon tax, tax receipts $(\phi_i + \tau)X_i$ are higher, which reduces the need to resort to lump-sum taxes T_{ci} at first best or additional distorsive taxes ψ_i at second best, to finance public spending.
- $\Longrightarrow$ at second best the marginal cost of public funds is lower with carbon tax than without $\Longrightarrow$ higher public spending: the carbon tax also helps to finance public spending.

Comparison of first best and second best with carbon tax

- Marginal utility of public spending equal to its total cost, namely 1 at first best, and $1 + \mu_i$ at second best $\Longrightarrow G_i$ smaller at second best than at first best.
- First best: public goods provision financed through lump-sum taxes and the only role of commodity taxation $(\theta_i = \phi_i + \tau)$ is to limit emissions.
- Second best: commodity taxation has to achieve the two objectives. New component ψ_i. Total taxes θ_i higher, inducing a lower level of emissions. This is why even if total taxes are higher, the Pigouvian taxes ϕ_i and τ are smaller at second best than at first best.

Country 1 values public spending more than country 2, same βs

Country 1									
	X_1	G_1	T_{c1}/ψ_1	ϕ_1	τ/τ_1	θ_1	T_1	μ_1	U^1
1st best	28.6	24.9	-8.6	0.085	0.372	0.457	13.9	0	447.6
2nd best	27.0	17.7	0.317	0.053	0.158	0.528	7.7	0.33	446.5
3rd best	25.2	15.6	0.435	0.038	0.149	0.587	3.7	0.47	441.3
Country 2									
	X_2	G_2	T_{c2}/ψ_2	ϕ_2	τ/τ_2	θ_2	T_2	μ_2	U^2
1st best	28.6	15.3	-5.5	0.085	0.372	0.457	7.4	0	393.1
2nd best	27.0	10.9	0.317	0.053	0.158	0.528	0.9	0.33	392.1
3rd best	29.1	12.7	0.172	0.077	0.187	0.436	5.5	0.17	396.8

- Second best: the IEA gives to country 1 a transfer larger than the carbon tax it has paid in order to allow it to consume more public good.
  Shows that the IEA may give large transfers to one country not only for equity but also because of the characteristics of preferences.
- Third best: without transfers from country 2, country 1's marginal cost of public funds increases a lot as it must resort to a high level of distortionary taxation to finance its public spending. Country 2 benefits (in terms of welfare), whereas country 1's welfare is lower than at the second best.

Conclusion

- Preexisting energy taxation and the presence of public goods that have to be financed does not necessarily imply to abandon the idea of a uniform carbon tax.
- Subsidiarity principle.
- However, the implementation of international transfers, for equity or other reasons linked to preferences, is required.
- Answer to Sandmo 2005: "Should one design compensatory transfers [between rich and poor countries], or should the design of the environmental taxes themselves have built-in distributional elements?"
- If for various political economy reasons these inter-country transfers prove to be impossible, the carbon tax must be differentiated across countries.
- Further research: approach this problem empirically.