The Economics of Climate Change: Problem Set
- Example Solution-

Optimal instrument choice

Assume that there are two identical firms A and B with polluting production plants. The two firms can reduce emissions of the pollutant at marginal costs of

$$MC_A = 18x_A$$

$$MC_B = 6x_B$$

1. *What is the welfare maximizing allocation of emission reductions in this situation if the total emissions in the economy should be reduced by 20 units? Calculate the overall abatement cost for the economy.*

Solution:
Two conditions for a welfare maximizing allocation: $x_A + x_B = 20$, $MC_A = MC_B$;
$\rightarrow x_A = 5$, $x_B = 15$, $C_A + C_B = 9 \times 5^2 + 3 \times 15^2 = 900$

2. *What per unit emission tax needs to be imposed on the two firms to reach an overall abatement of 20 units in the economy?*

Solution:
Condition for welfare maximizing per unit tax: $MC_A = MC_B \rightarrow t = 90$

Now assume that the aggregate marginal abatement cost function for the economy is given by

$$MC_{A+B} = 4.5X$$

and the marginal damages are given by

$$MD = 150 - 0.5X$$

3. *What is the efficient level of overall abatement in the economy? Is the per unit emission tax derived above appropriate to reach the efficient level of overall abatement? If not, what per unit emission tax needs to be set to achieve the efficient level of abatement?*

Solution:
Condition for efficient level of overall abatement: $MC_{A+B} = MD \rightarrow x = 30$, $x_A = 7.5$, $x_B = 22.5$, $t = 135$

4. *Generally, given the relative slopes of the Marginal Damages and Marginal Abatement Cost curves, is a price or a quantity regime preferable in the context of climate change?*

Possible answer:

- If there is uncertainty about the marginal abatement costs (MC) and the marginal damages (MB), price and quantity regulation is not equivalent any longer (see Weitzman, 1974).

- The aggregate welfare loss depends on the relative slope of the two curves.

- If MB curve is relatively flat and MC curve is relatively steep: price instrument is more efficient.

- If MB curve is relatively steep and MC curve is relatively flat: quantity instrument is more efficient.

- Given the expected relative slopes in the context of climate change (MB curve relatively flat, MC curve relatively steep; at least in the short term), a price instrument is preferred.

5. *Would hence a harmonized global carbon tax be preferable to a global emissions trading system? Please, consider also issues of enforcement.*

Possible answer:

- According to Weitzman's theory, a global carbon tax should be preferred to a global emissions trading system.

- However, states have fiscal sovereignty and therefore might undermine the effect of a global carbon tax by either

    * reducing fees that indirectly tax carbon (e.g. fuel levies) or by

    * subsidizing carbon intense production processes (e.g. coal subsidy).

- Undermining the effect of a global carbon tax by reducing the effective tax rate is known as 'fiscal cushioning'.

- Fiscal cushioning reduces the environmental effectiveness of a global carbon tax.

- The enforcement of a quantity-based instrument such as a global emissions trading system is stricter than that of a global carbon tax.

- Given the problem of fiscal cushioning, a global emissions trading system would be more effective.

6. *Now let us consider a country that has implemented an emissions trading system. What arguments can support the introduction of an additional subsidy on research and development (R&D) in the field of abatement technologies?*

Possible answer:

- 'Tinbergen rule': One policy instrument for each policy objective.

- If there are multiple policy goals, multiple instruments can be justified.

- In case of climate change mitigation, policy goals other than CO_2 emissions abatement are, for example, enhancing energy efficiency, increasing energy security, spurring innovation in abatement technologies, promoting technology adoption.

- An additional subsidy on research and development in the field of abatement technologies can thus be useful to increase innovation beyond the incentives from the ETS (especially if there are knowledge-spillovers that lead to an underinvestment in R&D on the part of private investors).

Economics of the Clean Development Mechanism

Carbon offsets, such as generated by the Clean Development Mechanism, are often disputed as an instrument for effective climate policy.

Is Switzerland's decision to restrict the use of CDM certificates in the years to come economically sound? Discuss advantages and disadvantages from an economic perspective.

Arguments in favor of a restriction:

- Emission reductions within Switzerland incentivize technological innovation.

- Emission reductions within Switzerland potentially create local employment and economic growth.

- The local industry may profit from the so-called 'first-mover advantage', if Swiss technologies are adopted in other countries.

- Emission reductions can be verified and monitored more easily, compared to emission reductions abroad.

Arguments against a restriction:

- Emission reductions abroad minimize the overall abatement costs as marginal abatement costs abroad might be lower (especially in developing countries and countries in transition).

- Reduced opportunities for technology transfer to developing countries and countries in transition.

- Reduced incentive for developing countries and countries in transition to engage in climate change abatement.