Environmental Assessment

Fachbereich 2 Informatik und Ingenieurwissenschaften

Policy instruments – efficiency

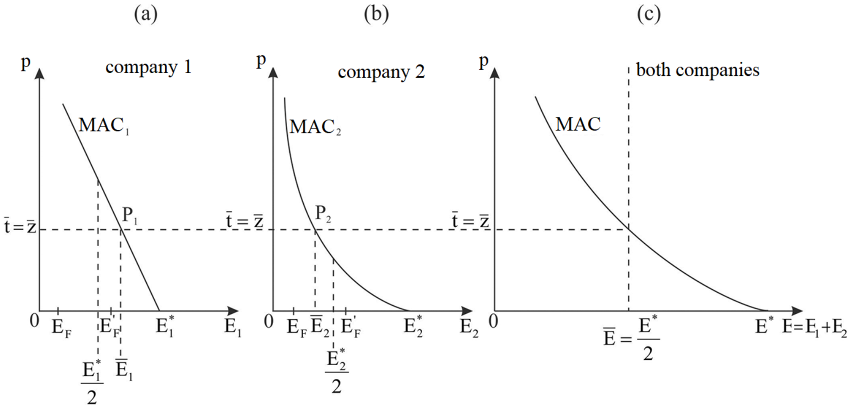

Figure: With adjustments taken from Endres (2022)

Policy instruments – exercise

Assume two countries 1 and 2 with different MAC and emissions E_1 and E_2

$$MAC_1 = 20 - 2E_1$$
$$MAC_2 = 10 - E_2$$

Assume no emission abatement in the business as usual scenario.

a) Calculate the amount of emissions in the business as usual scenario

b) Assume an obligation for both countries to cut emissions by 45 %. Calculate abatement costs (AC) for both countries and in total.

Policy instruments – exercise

Assume two countries 1 and 2 with different MAC and emissions E_1 and E_2

$$MAC_1 = 20 - 2E_1$$
$$MAC_2 = 10 - E_2$$

Instead of an obligation, emission allowances are introduced. Assume each country is assigned free certificates for 55 % of their emissions. Their shall be perfect competition at the allowance market.

c) Calculate the price for allowances
d) Are allowances traded? Which country is buying and which country is selling certificates? What is the impact?
e) Calculate AC after introduction of emissions trading. Compare it to AC in an obligation framework.

Policy instruments – exercise

Assume two countries 1 and 2 with different MAC and emissions E_1 and E_2

$$MAC_1 = 20 - 2E_1$$
$$MAC_2 = 10 - E_2$$

Now free assignment of allowances is exchanged by auctioning off emission certificates.

f) Does the introduction of auctions for emission certificates change emissions of the two countires?

g) Calculate total cost C for each country after introduction of auctions for certificates.

h) Assume that country 1 after negotiations is allowed to cut emissions by 25 % instead of 45 %. How does it affect the two countries' trading balance?

Policy instruments – innovation incentives

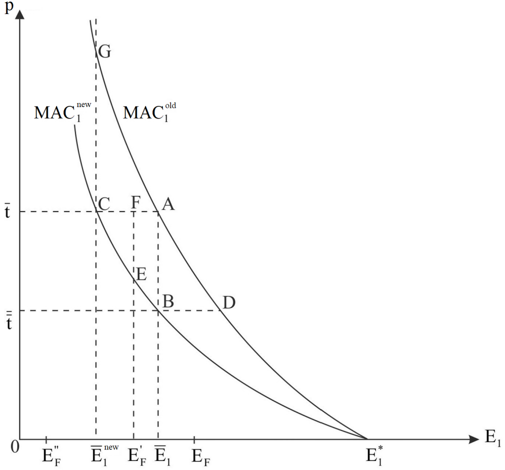

Figure: With adjustments taken from Endres (2022)

Policy instruments – accuracy

- obligations and allowances allow an accurate determination of the emission level

$\rightarrow$ difficulties may occur if they aim at intensities instead of total emissions

$\rightarrow$ different treatment of old and new utilities can be problematic

- tax rates need an adjustment if a constant emission objective shall be established (inflation, technological progress)
- accuracy is less important close to E^* while it becomes more important close to E^*

Policy instruments – time sequence

- ETS and emission tax have advantages with respect to efficiency when compared to obligations
- without adjustments innovation incentives are highest for the emission tax
- accuracy is highest for obligations and the ETS
- investment incentives are best for an emission tax

$\Rightarrow$ close to E^* the emission tax is superior to the other policy instruments while later the ETS is superior

Introduction of the EU ETS

Everything has started with a failure...

- the EU Commission suggested on June 2, 1992 the introduction of a carbon tax

$\Rightarrow$ opposition from Member States because of tax autonomy

$\Rightarrow$ opposition from industry lobbies, particularly UNICE (now: BusinessEurope)

- tax proposal was officially withdrawn in 1997
- on December 11, 1997 the Kyoto Protocol was signed

$\Rightarrow$ incentives for emission reduction necessary

Kyoto Protocol negotiations

According to Convery (2009) the EU had three main positions during negotiations:

- "*a commitment to mandatory caps on emissions by developed countries*"
- "*an undifferentiated target of minus 15 %*"
- "*antipathy to emissions trading as a mechanism for achieving these targets*"

⇒ reason: participants whose caps include "hot air" would benefit without any effort

The Kyoto Protocol

results:

- industrialized countries obliged themselves for the time period between 2008 – 2012 with an averaged emission reduction of 5.2 % when compared to 1990.
- emissions trading as voluntary instrument was intended in the Protocol

⇒ the EU failed with the 15 % goal and their opposition against emissions trading

⇒ insistence of the US delegation

Participation in the Kyoto Protocol

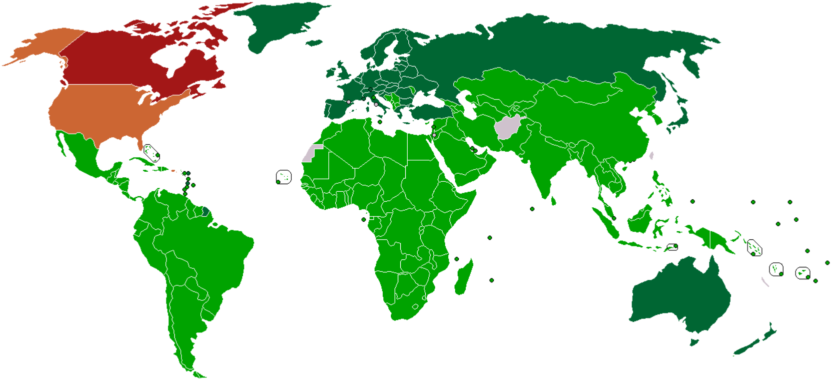

Figure: Countries participating in the Kyoto Protocol until 2010; source: Wikipedia

Absolute versus intensity caps

- an ETS can introduce an absolute emission cap $E^{'}$ or a threshold value for the emission intensity $e^{'}$

$$e = \frac{E}{Y} \tag{1}$$

$\rightarrow$ Y corresponds to the output

$\Rightarrow$ emission intensity has the unit e.g. [g/kWh]

- Is it better to install an absolute cap or an intensity-based cap?

Absolute versus intensity caps

- emissions abatement with an absolute cap equals

$$A^{A} = E^{*} - E^{'} \tag{2}$$

→ E^{*} indicates the emission level in the business-as-usual scenario (BAU-scenario) without ETS and

→ $E^{'}$ corresponds to the absolute emission cap

- emissions abatement with an intensity-based cap equals

$$A^{I} = E^{*} - e^{'}Y \tag{3}$$

→ $e^{'}$ corresponds to the intensity-based emission cap

→ Y corresponds to the output level after introduction of the ETS

Absolute versus intensity caps – exercise

Imagine you are responsible for evaluation of a reasonable intermediate emission objective.

- How would you determine the intermediate objective?

$\rightarrow$ Which information would you need?

$\rightarrow$ Which aspects would you consider?

- How would you deal with deviations from your intermediate objective?

$\Rightarrow$ The lower the deviation, the better (if the intermediate objective is optimal)

Intermediate objectives and uncertainty

- emissions abatement with an absolute cap

$$E[A^A] = E[E^*] - E^{'} \tag{4}$$

$\rightarrow$ $E[]$ indicates an expectation value

- emissions abatement with an intensity-based cap

$$E[A^I] = E[E^*] - e^{'} E[Y] \tag{5}$$

Deviation from optimal objectives

- variance for emissions abatement with an absolute cap

$$var[A^A] = var[E^*] \tag{6}$$

- emissions abatement with an intensity-based cap

$$var[A^I] = var[E^*] - 2e^{'}cov[E^*, Y] + e^{'2}var[Y] \tag{7}$$

$\Rightarrow$ Is the variance lower with an absolute emission cap or an intensity-based emission cap?

Excursus – basic statistics

- variance

$$var[x] = \frac{1}{n}\sum_{i=1}^{n}(x_i - E[x])^2 \qquad (8)$$

→ quadratic deviation from the expectation value

- standard deviation

$$s[x] = \sqrt{var[x]} \qquad (9)$$

→ standardized deviation in "right units"

Excursus – basic statistics

- coefficients of variation

$$\nu[x] = \frac{s[x]}{E[x]} \tag{10}$$

$\rightarrow$ relative standard deviation from the expectation value

Excursus – basic statistics

- covariance

$$cov[x,y] = \frac{1}{n}\sum_{i=1}^{n}(x_i - E[x])(y_i - E[y]) \tag{11}$$

→ joint variance of two variables

→ high positive values indicate "simultaneous deviations" of the two variables indicating a correlation

- correlation coefficient

$$\rho[x,y] = \frac{cov[x,y]}{s[x]s[y]} \tag{12}$$

→ standardized correlation with values between -1 and 1

Minimizing deviations

- If the variance for an intensity-based emission cap is lower than for an absolute emission cap, we receive

$$
\begin{aligned}
& var[A^I] < var[A^A] \\
\Rightarrow & e'^2 var[Y] < 2e' cov[Y, E^*] && (13) \\
\Leftrightarrow & \frac{\nu[Y]}{\nu[E^*]\rho[Y, E^*]} \frac{E'}{E[E^*]} < 2 && (14) \\
\Rightarrow & \xi \frac{E'}{E[E^*]} < 2 && (15)
\end{aligned}
$$

$\Rightarrow$ approach follows Sue Wing *et al.* (2009)

FRANKFURT UNIVERSITY OF APPLIED SCIENCES

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