FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Environmental Assessment

Fachbereich 2 Informatik und Ingenieurwissenschaften

Pigouvian tax

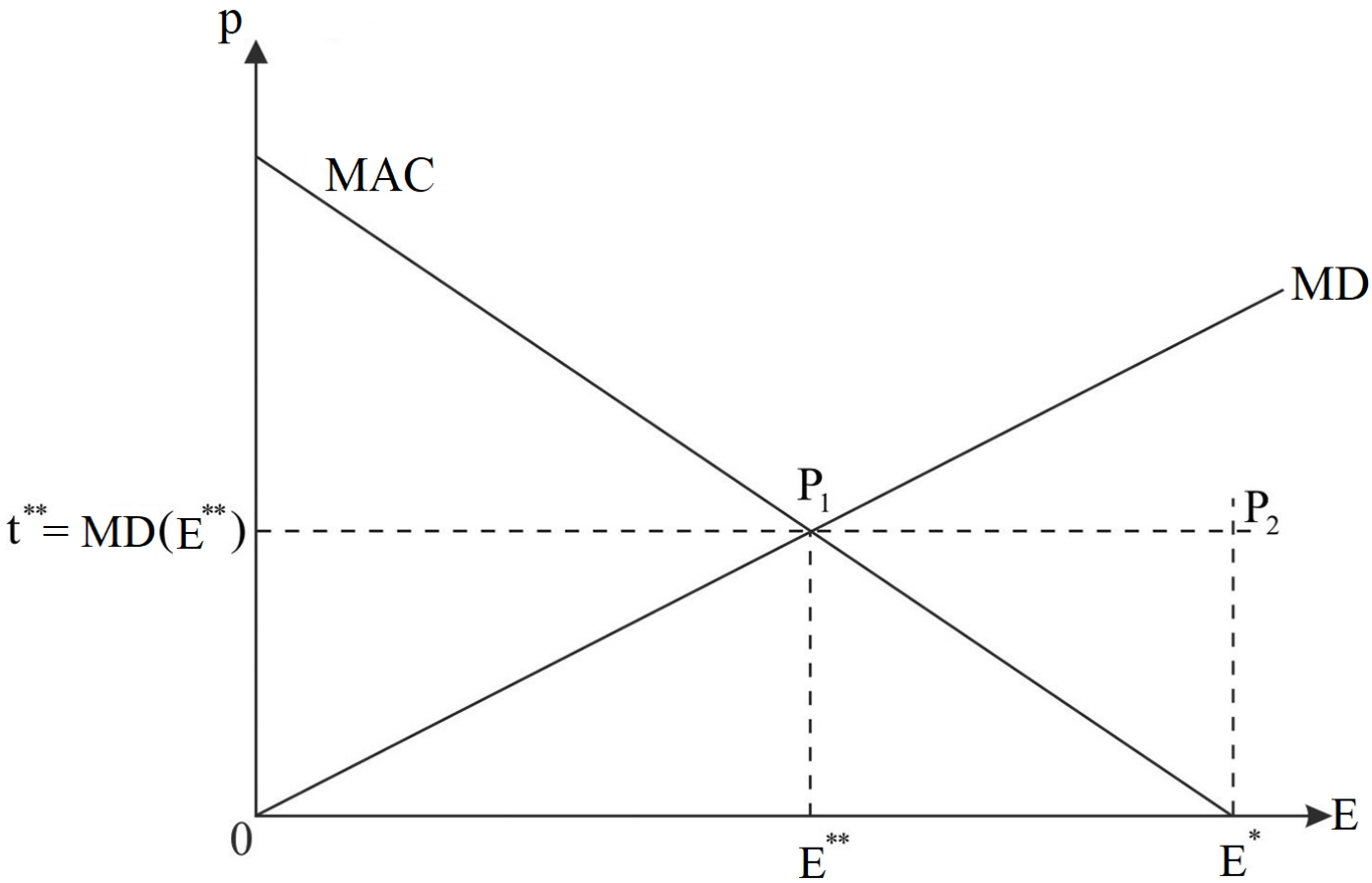

Figure: With adjustments taken from Endres (2022)

Pigouvian tax and subsidy

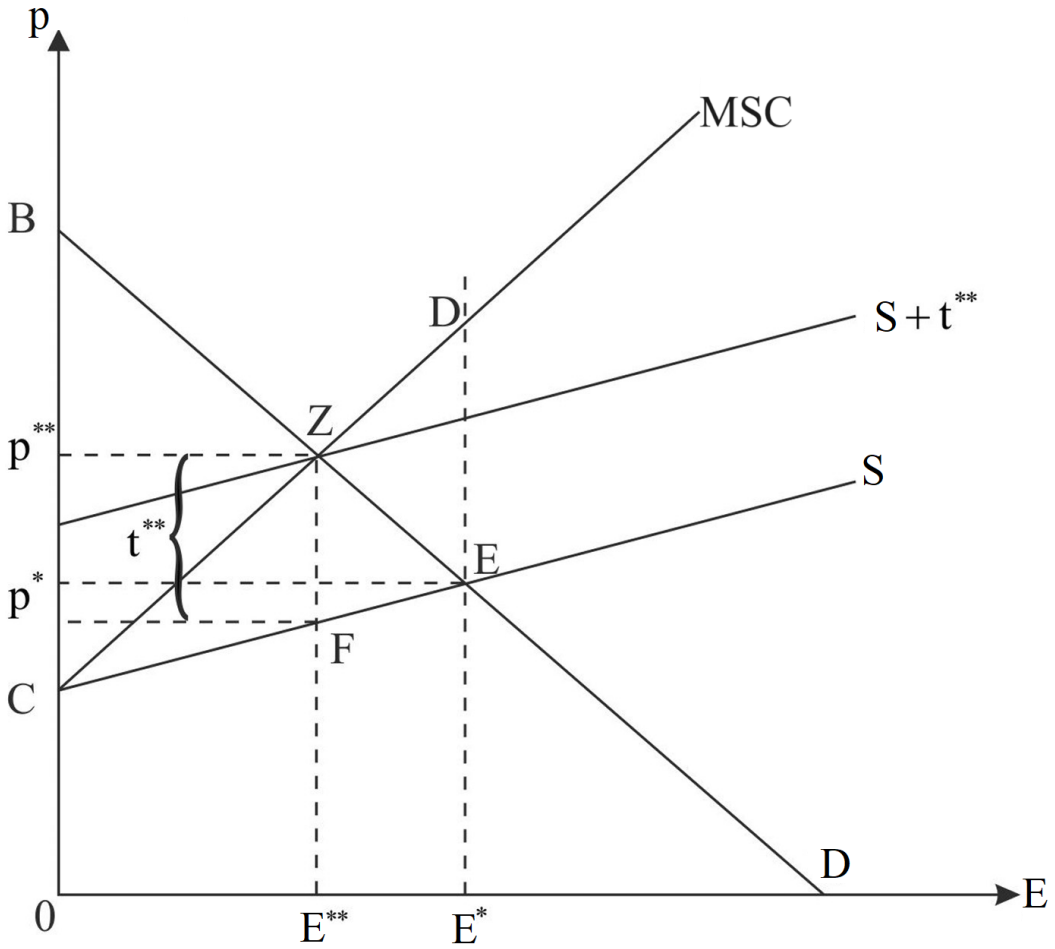

Figure: With adjustments taken from Endres (2022)

MAC, MSC – exercise

Assume a market under perfect competition with supply

$$p = \frac{1}{2}E + 2$$

and demand

$$p = 20 - E.$$

Marginal damage from emissions corresponds to

$$MD = \frac{5}{2}E.$$

a) Calculate the market equilibrium E^*

b) Derive marginal abatement cost MAC and marginal social cost MSC.

c) Calculate the socially optimal emission E^{**} level using a) MAC and b) MSC.

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Pigouvian tax – exercise

Assume a model economy with a sector producing an output X proportional to emissions E ($E = e \cdot X$ with $e = 1$). The maximum emissions of the sector equal 6 ($0 \leq E \leq 6$). Marginal abatement costs of the sector are

$$600 - 100E$$

while damage from emissions equals

$$D(E) = 25E^2$$

a) Calculate marginal damage MD.

b) Calculate the socially optimal output level of the company.

c) What is the tax rate of a Pigouvian tax?

d) Illustrate your results.

e) What happens if the government abolishes the tax and introduces a subsidy $s = 100$?

Policy instruments for emission reduction

- obligations

$\rightarrow$ define a threshold value or intensity for **every emitter**

- taxes/subsidies

$\rightarrow$ defining a tax/subsidy rate t/s which results in a certain emission level $E^{'}$

$\Rightarrow$ partial internalization if $t<\text{MD}(E^{**})$

- allowances or emission certificates

$\rightarrow$ define a threshold value $E^{'}$ or intensity for **a sector, countries, the world** allowing trade between emitters

$\Rightarrow$ partial internalization if $E^{'}>E^{**})$

Degree of internalization

- The degree of internalization can defined as

$$\Delta(E^{'}) := \frac{IC(E^{'})}{AC(0, E^{'})}. \tag{1}$$

  with $IC(E^{'}) = T$.

- For

$$p(E^{'}) = MAC(E^{'}) = d(E^{*} - E^{'})^{n} \qquad \forall n > 0 \tag{2}$$

  price p or tax rate t are sufficient indicators for the degree of internalization

Choice of policy instruments

- Which policy instrument to choose with respect to

→ efficiency

→ innovation incentives

→ accuracy

- What about a combination of policy instruments?

Policy instruments – efficiency

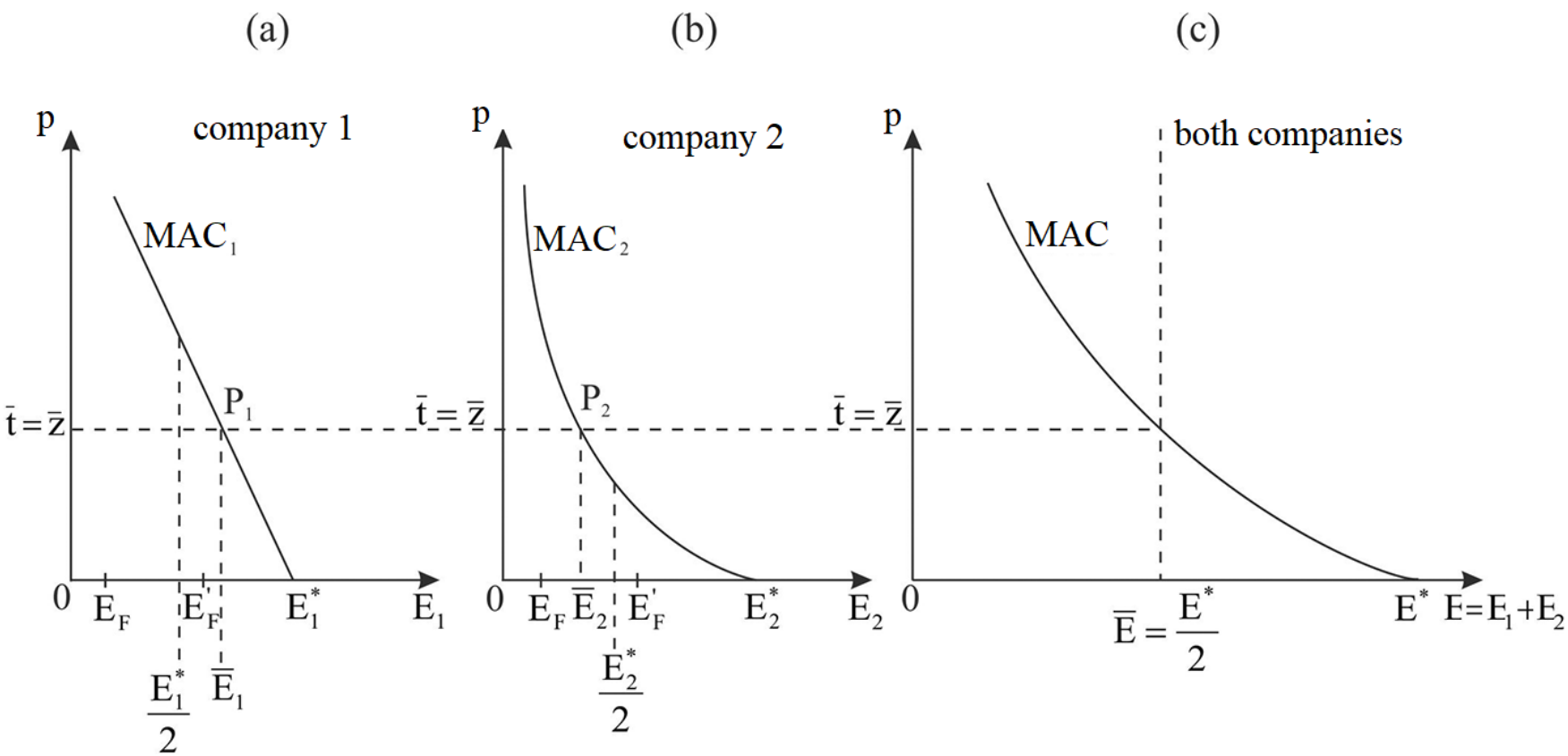

Figure: With adjustments taken from Endres (2022)

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 2 after negotiations is allowed to cut emissions by 25 % instead of 45 %. How does it affect the two countries' trading balance?

References

Endres, A. (2022). *Umweltökonomie*. Kohlhammer.