FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Environmental Assessment

Fachbereich 2 Informatik und Ingenieurwissenschaften

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

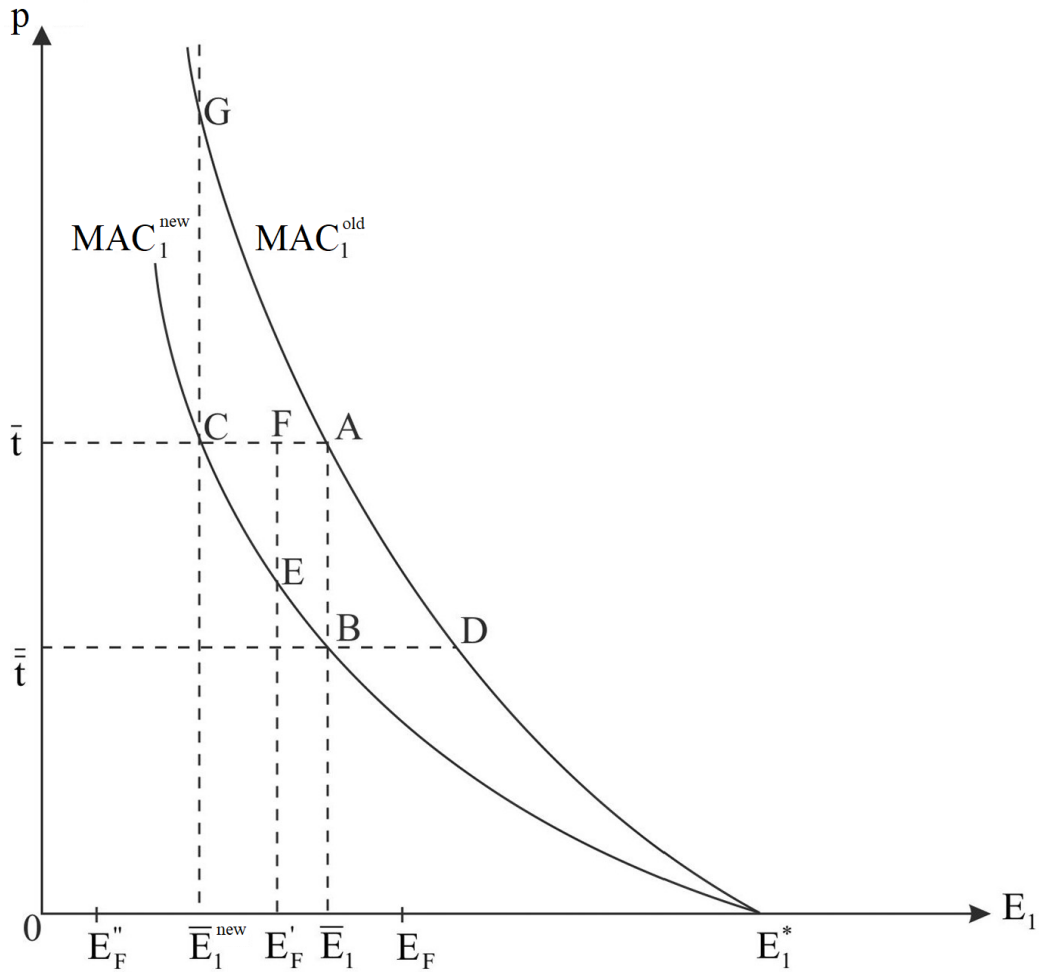

Figure: With adjustments taken from Endres (2022)

Policy instruments – 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

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

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

$\rightarrow$ E^* indicates the emission level in the business-as-usual scenario (BAU-scenario) without ETS and

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

- emissions abatement with an intensity-based cap equals

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

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

$\rightarrow$ Y corresponds to the output level after introduction of the ETS

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

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

$\rightarrow$ $E[A]$ is the decisive variable to counteract climate change!

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?

Minimizing deviations

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

$$
\begin{aligned}
& var[A^I] < var[A^A] \\
\Rightarrow & e'^2 var[Y] < 2e' cov[Y, E^*] && (8) \\
\Leftrightarrow & \frac{\nu[Y]}{\nu[E^*]\rho[Y, E^*]} \frac{E'}{E[E^*]} < 2 && (9) \\
\Rightarrow & \xi \frac{E'}{E[E^*]} < 2 && (10)
\end{aligned}
$$

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

Excursus – basic statistics

- variance

$$var[x] = \frac{1}{n}\sum_{i=1}^{n}(x_i - E[x])^2 \tag{11}$$

$\rightarrow$ quadratic deviation from the expectation value

- standard deviation

$$s[x] = \sqrt{var[x]} \tag{12}$$

$\rightarrow$ standardized deviation in “right units”

Excursus – basic statistics

- coefficients of variation

$$\nu[x] = \frac{s[x]}{E[x]} \tag{13}$$

$\rightarrow$ relative standard deviation from the expectation value

Excursus – basic statistics

- covariance

$$cov[x, y] = \frac{1}{n} \sum_{i=1}^{n} (x_i - E[x])(y_i - E[y]) \tag{14}$$

→ joint variance of two variables

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

- coefficient of determination

$$\rho[x, y] = \frac{cov[x, y]}{s[x]s[y]} \tag{15}$$

→ standardized correlation with values between -1 and 1

Minimizing deviations – exercise

Assume the expectation value approximately corresponds to the ten year average with a time lag of three years.

- Use the data for the German electricity market to calculate ξ for the years 2007 until 2024
- Illustrate your results in an appropriate diagram.
- What do you think about the approximation?

Introducing emissions trading in the EU

- burden sharing agreement in June 1998
- the European Commission released a paper in June 1998 which stated that "the Community could set up its own internal trading regime by 2005"
- in 1999 the "could" turned into "should" (Convery, 2009)
- in March 2000 the so-called "Green Paper" was released by the European Commission

$\rightarrow$ According to Convery (2009) "*the tone and tenor of the paper assumed that the decision to proceed and establish a Community wide emissions trading scheme had already been taken*"

$\rightarrow$ possibility to allocate certificates based on historical emissions

$\Rightarrow$ emissions cap is based on absolute emissions

From proposal to enactment

- the EU ETS started on January 1, 2005

→ pilot period (2005-2007)

→ National Allocation Plans (NAPs) on a national level, consisting of a macro- and a mcro-plan, had to be established

→ certificates, also called European Allowances (EUAs), were not transferable to the 2nd trading period (2008-2012)

→ allocation of certificates was free (grandfathering)

EUA price development

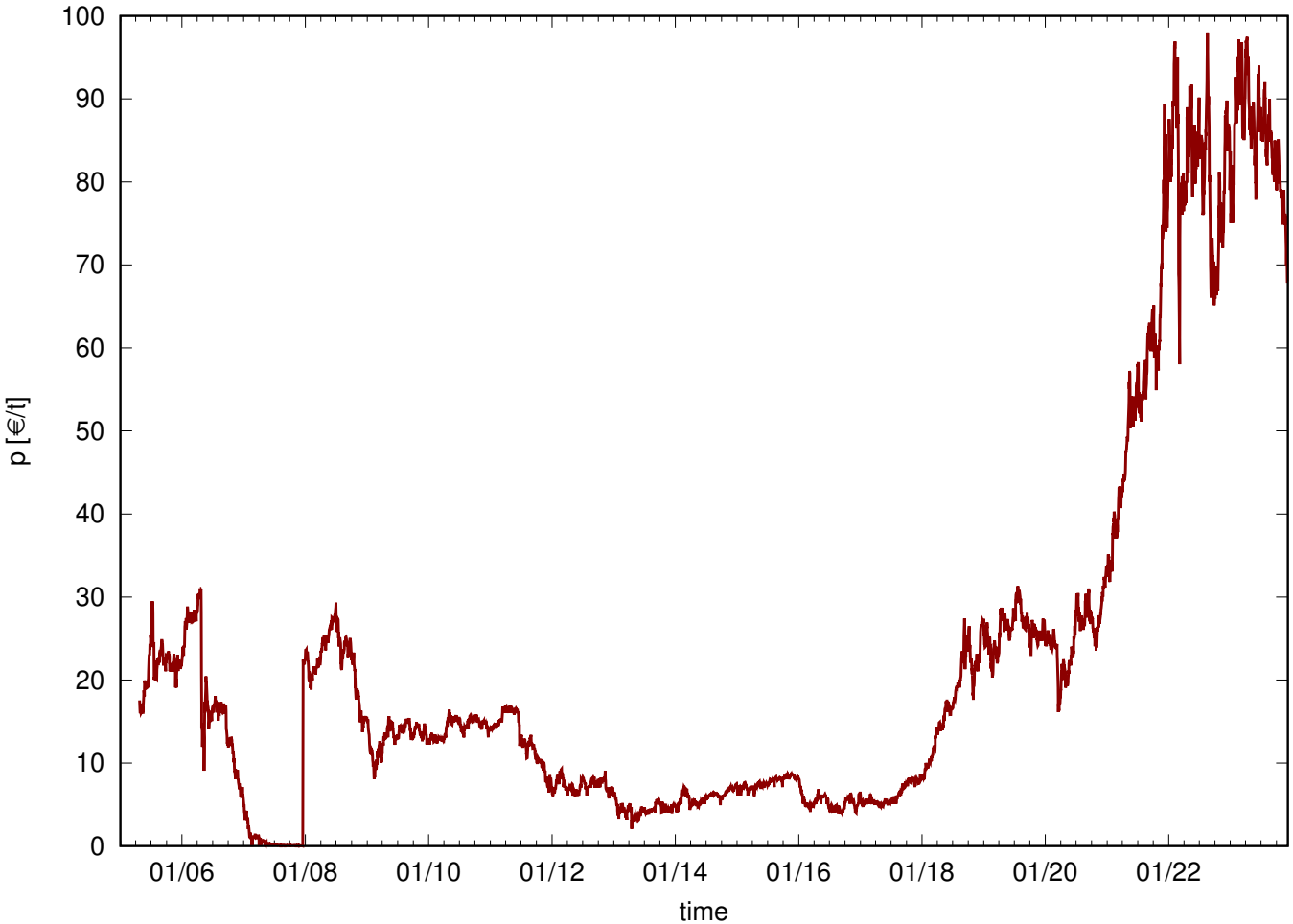

Figure: Development of the allowance price of the EU ETS between April 25, 2005 and December 6, 2023. Own illustration based on investing.com (2023).

Implementation in Germany

- EUAs were allocated based on historic emissions between 2000 and 2002 (base period) (Federal Ministry for the Environment, 2004, p. 8)
- Germany's NAP intended a reduction from assumed 501 Mt/year in the base period to 489 Mt/year with a reserve of 10 Mt/year for new emitters (Federal Ministry for the Environment, 2004, p. 22)

$\Rightarrow$ intended minimum reduction was 0.4 %

- In retrospect, it turned out, that emissions of the base period were only 482.4 Mt/year (Federal Ministry for the Environment, 2006, p. 49, footnote 14)

$\Rightarrow$ instead of 0.4 % reduction there was an increase of 1.4 %

- excessive EUAs were present all over the EU

2nd trading period 2008-2012

- more facilities included in the EU ETS

$\Rightarrow$ base period emissions increase to 493.4 Mt/year (Federal Ministry for the Environment, 2006)

- intended reduction objective was 482 Mt/year (2.3 %)
- NAP was rejected by the European Commission (2006) because likely emission reductions which are not induced by the EU ETS were not considered
- The Commission claimed at least to consider an annual decrease in emission intensity (ratio of emissions and GDP) of 0.5 %

$\Rightarrow$ revised NAP intended a reduction to 453.1 Mt/year (8.2 %) (Federal Ministry for the Environment, 2007)

- introduction of the Joint Implementation (JI) and the Clean Development Mechanism (CDM)

Joint Implementation and Clean Development Mechanism

- counting credits carried out in developing and emerging countries towards emissions in the EU

$\rightarrow$ Certified Emission Reductions (CERs)

$\rightarrow$ Emission Reduction Units (ERUs)

$\Rightarrow$ 1.445 billion CERs and ERUs were used in the EU until April 30, 2015

3rd trading period 2013-2020

- establishment of an EU-wide cap

$\Rightarrow$ no NAPs anymore

- cap is reduced by a linear factor amounting to 1.74 % of averaged emissions of the 2nd trading period starting form 2010 (European Commission, 2010)

$\Rightarrow$ $E_{2013} = (1 - 3 \cdot 0.0174)\bar{E}_{2008-2012} = 2{,}084{,}301{,}856$

$\Rightarrow$ annual reduction of 38,264,246

- the number of CERs and ERUs valid in the EU ETS has been limited
- requirements for admission of projects counting credits towards the EU has been tightened (European Commission, 2013)

4th trading period 2021-2030

- further use of an EU-wide cap
- the reduction factor of the cap is reduced is increased from 1.74 % to 2.2 %

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