ECN 275/375 Environmental and natural resource economics 5: Pollution control – instruments (1) Perman *et al.* Sec 6.1-6.4

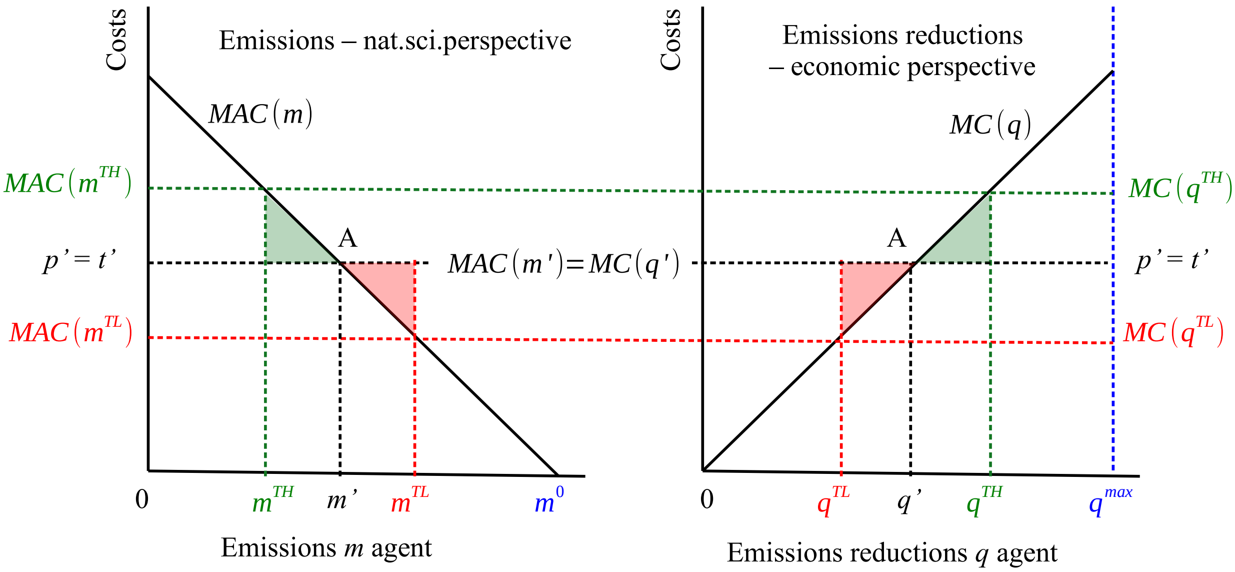
Reading guide

Perman *et al.* Section 6.1-6.4 (read for overview, sections 6.2 and 6.4 particularly important)

- Section 6.1 – Criteria for selection (see table 6.1, p. 178), cost effectiveness and dependability (= ability to reach the target) most important in short term, flexibility and dynamic efficiency in the long run (and it hinges on cost.eff + ability to reach target)
- Section 6.2 – deals with cost effectiveness. A must read.
  - Definition of the equi-marginal principle $MAC_i(M_i^{'}) = MAC_j(M_j^{'}) \forall i, j \in I$ where $M_i^{'}$ is the chosen emission level for agent *i*. → absence of arbitrage (= impossible to do better by reallocating emissions from $M_i^{'}$.
  - Figure 6.1 (p. 180): the equi-marginal principle (both firms have marginal abatement costs equal to 75, but with different abatement levels: the low cost cleaner abates more)
- Section 6.3 – Table 6.2 (read for overview to be aware of width in policy approaches)
  - Sub-section 6.3.1.1 – Coase theorem, Table 6.2 (p. 180) gives a quick glance
  - Sub-section 6.3.2.2 – on technology standards BPM + BAT + BATNEEC
- Section 6.4 – Economic incentive (quasi market instruments)
  - emission taxes/tradable emission permits, contrast non-tradable permits (fixed emission)
  - Sub-section 6.4.2.1 Initial allocation of permits (main story: "grand-fathering" = free allocation based on some criteria like historic emissions, not a good idea)

In class

A polluter's (index *i* dropped) choice of emission level *m'* (left panel) or emissions reductions *q'* (right panel) at tax *t'* or a permit price *p'*



Green triangles: excessive abatement costs by reducing emissions too much m^{TH} (left) // q^{TH} (right)
Red triangles: extra tax payment/lost income by reducing emissions too little m^{TL} (left) // q^{TL} (right)

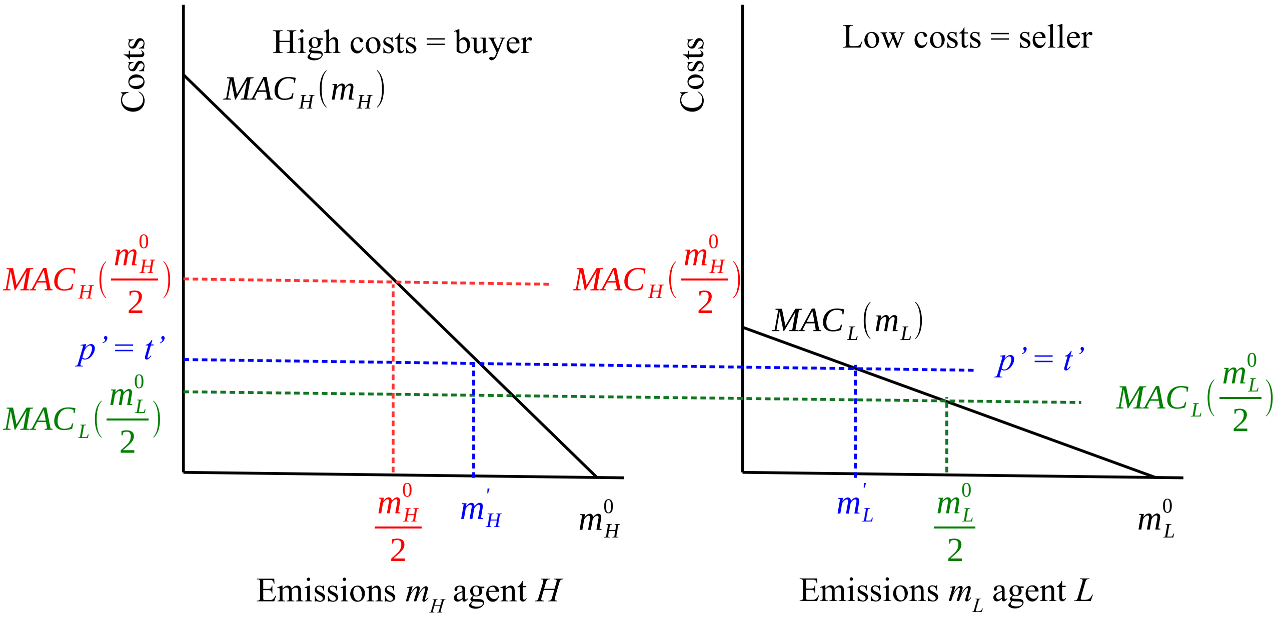
Total abatement costs for emissions *m'* in left panel:

$$TAC' = \int_{m'}^{m^0} MAC(m)\,dm = |_{m'}^{m^0} TAC(m) = TAC(m') - TAC(m^0)$$ = triangle 0A*m'*

The total costs of providing emissions reductions *q'* in right panel is left in separate exercise.

High and low cost polluter responses to at tax or a tradable emission permit

High (subscript *H*) and low (subscript *L*) abatement cost polluters' responses to a tradable permit system that gives the price *p'* when total emissions have to be reduced by a half from initial emissions. For simplicity the high and low abatement cost polluters have equally large initial emissions and have to reduce emissions equally much under non-tradable permits.



Note that

1. The marginal abatement costs evaluated under fixed emission permits $m_H^0/2 = m_L^0/2$ differ.
2. Under the tradable permit market: The marginal abatement costs evaluated at chosen emission levels, $m_H^{'} = m_L^{'}$ are the same for the low and high abatement cost polluters, i.e., $MAC_H(m_H^{'}) = MAC_L(m_L^{'}) = p'$,and that the high abatement cost producer ends up with higher emissions than the high abatement cost polluter, i.e., $m_H^{'} > m_L^{'}$.
3. This graph is constructed so that the emission tax equals the tradable emission permit price, i.e., $t' = p'$. As there is no uncertainty involved, the tax regime gives the same solutions as the tradable permit regime. This is because both polluters reach to the incentive (the price or the tax) in the same way.

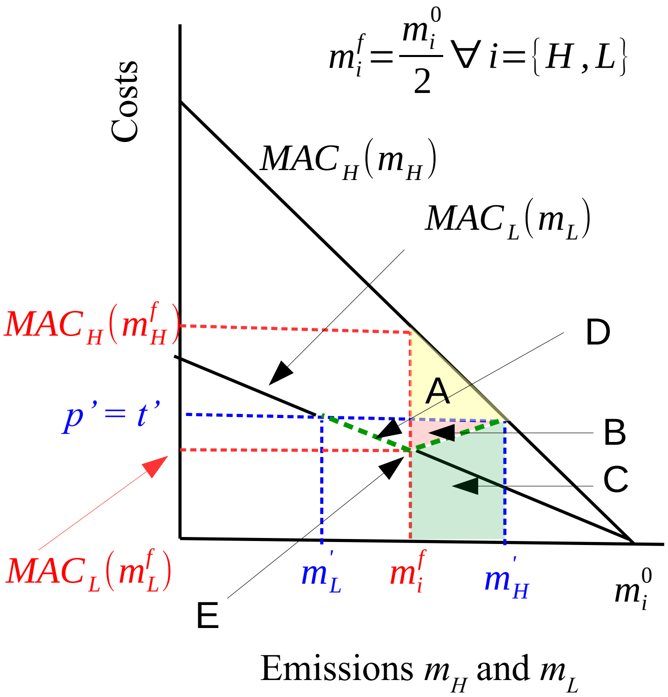
In the above figure, the marginal abatement cost functions are drawn as straight lines. The same principal solution would result if the marginal abatement costs functions were curved and monotonous.

On the next page the figure above is presented a bit differently, but in a way more directly illustrates the welfare gains (reduced dead weight losses) from using emission taxes or tradable permits compared to non-tradable emission permits.

Let the emission tax rate, *t*, and tradeable emission permit (quota) pric, *p*, be the same same, i.e., $t' = p'$.

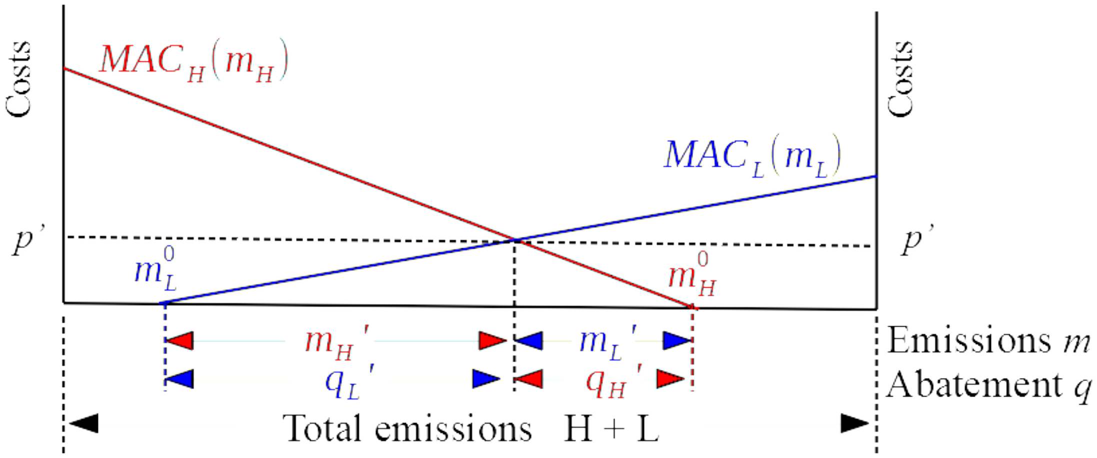
Then the same result will emerge if one superimposes the two MAC-curves in the above example into one graph. One benefit of this is that gains in welfare (reduced losses) are even easier to see. In the figure to the right this is illustrated by the triangles A (yellow) and B (pink). Note that the size of the triangle B = size of triangle D (white triangle just to the left of triangle B).

The MAC-curves (or the MC-curves if this graph had been drawn in emissions reductions space) will often be curved and convex with increased emissions reductions). In that case the resulting shape will be polygons with three cornes and a curved line bordering the MAC-curves.



Bathtub diagrams

Bath tub are often used to illustrate the cost effective solution when different sectors have been given different initial emission targets (or different emission reduction targets). Again, w get to the cost effective solution. The width of the bathtub illustrates the total allowed emission level.



Note that if we change the width of the bath tub, we will still find a cost effective solution, but that this solution results in a lower quota price, *p*, if we widen the bathtub, and a higher quota price if the bathtub becomes more narrow.

Bathtub diagrams are particularly beneficial for illustrating the effects of exemptions from environmental policies, as the exemption for one polluter (or polluting sector) becomes the extra burden for another party (or polluting sector).

Exercises

Go to the exercises section on the course web page.

Group problem

Bathtub diagrams

1. Draw a bathtub diagram for emissions (= width of diagram) and show that if the bathtub becomes wider in allowed emissions, the quota price is reduced
2. Draw a bathtub diagram for emissions reductions (= width of diagram) and show that if the bathtub becomes wider in requred emissions reductions, the quota price becomes higher

Discussion topics

1. Why would polluters generally prefer tradable emission permits over emission taxes. Hint: draw a graph that shows the tax payments compared polluters outlays if permits are given for free (grandfathered).
2. What is the main benefit of grandfathered emission permits? Hint: think ease of implementation of the permit system.
3. Why should tradable permits not be given for free (grandfathered), for example based on historical emissions?
4. Why are emission taxes incentive compatible and why do they meet the participation constraint (once implemented)? Hint: in this case, incentive compatibility and the participation constraints are overlapping.