# The Economics of Climate Change

C 175 - Christian Traeger

**Part 3: Policy Instruments**

continued

## Standards and Taxes

## Lecture 10

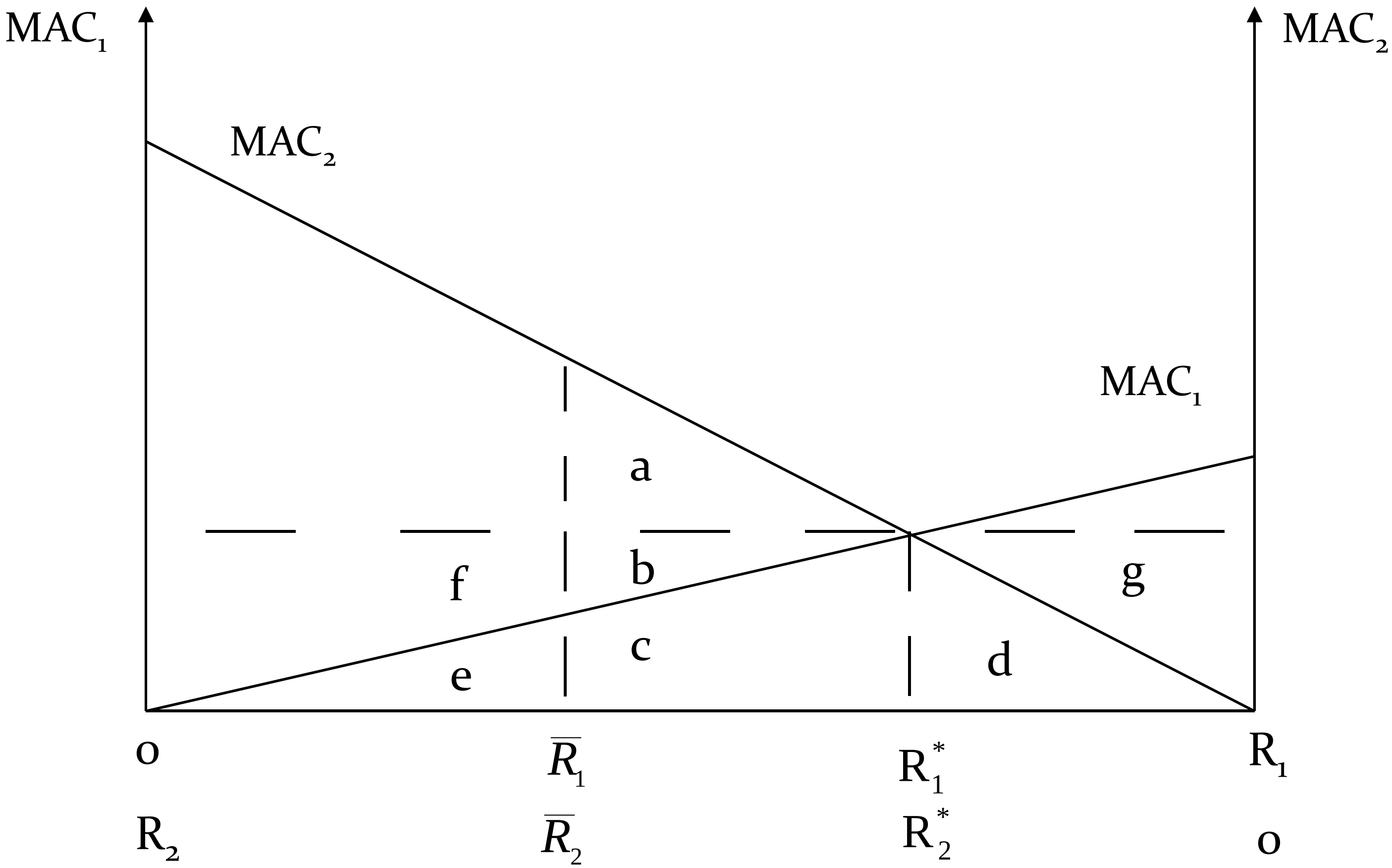
Read: Parry, I.W.H. & W.A. Pizer (2007), Emissions Trading versus $CO_2$ Taxes, Resources for the Future.

## Command and control (Standards)

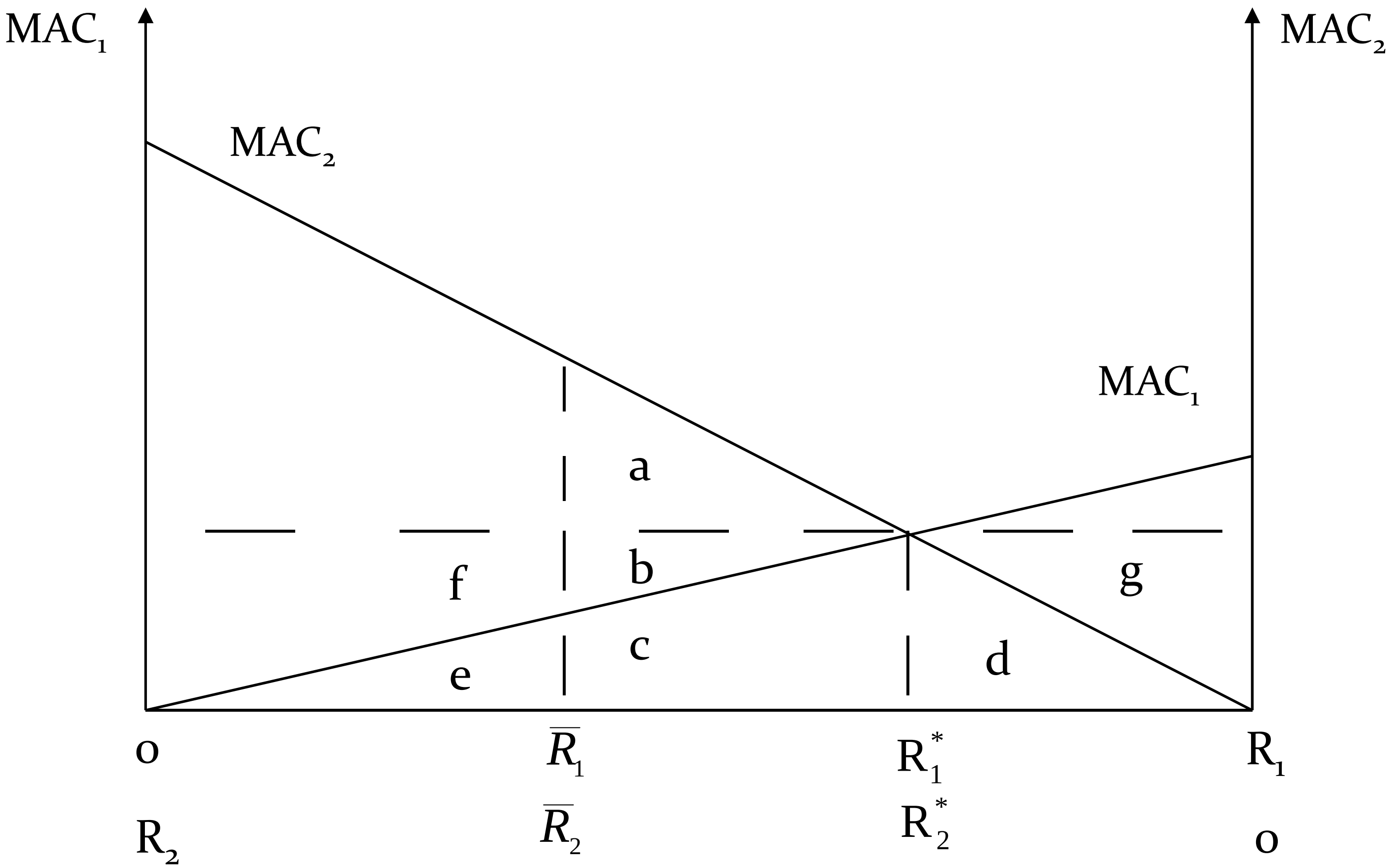
- Past environmental policy largely based upon direct regulation, or command and control (CAC)
  - Input control: ban on certain toxic inputs
  - Output control: each firm not allowed to emit more than X tonnes of pollutant Y
  - Technology control: requirement to use particular method or technology
    (e.g. BATNEEC= Best Available Technology Not Entailing Excessive Cost)
- Information requirement for static cost-effectiveness: government must know exact marginal costs of emission reduction of EVERY firm: not feasible
- Suppose government dictates emission reduction (output control) to 2 firms that differ in marginal abatement cost (MAC) functions, where MACs are not equalized

# Command and control

- Recall that efficiency requires that MAC equal over all firms

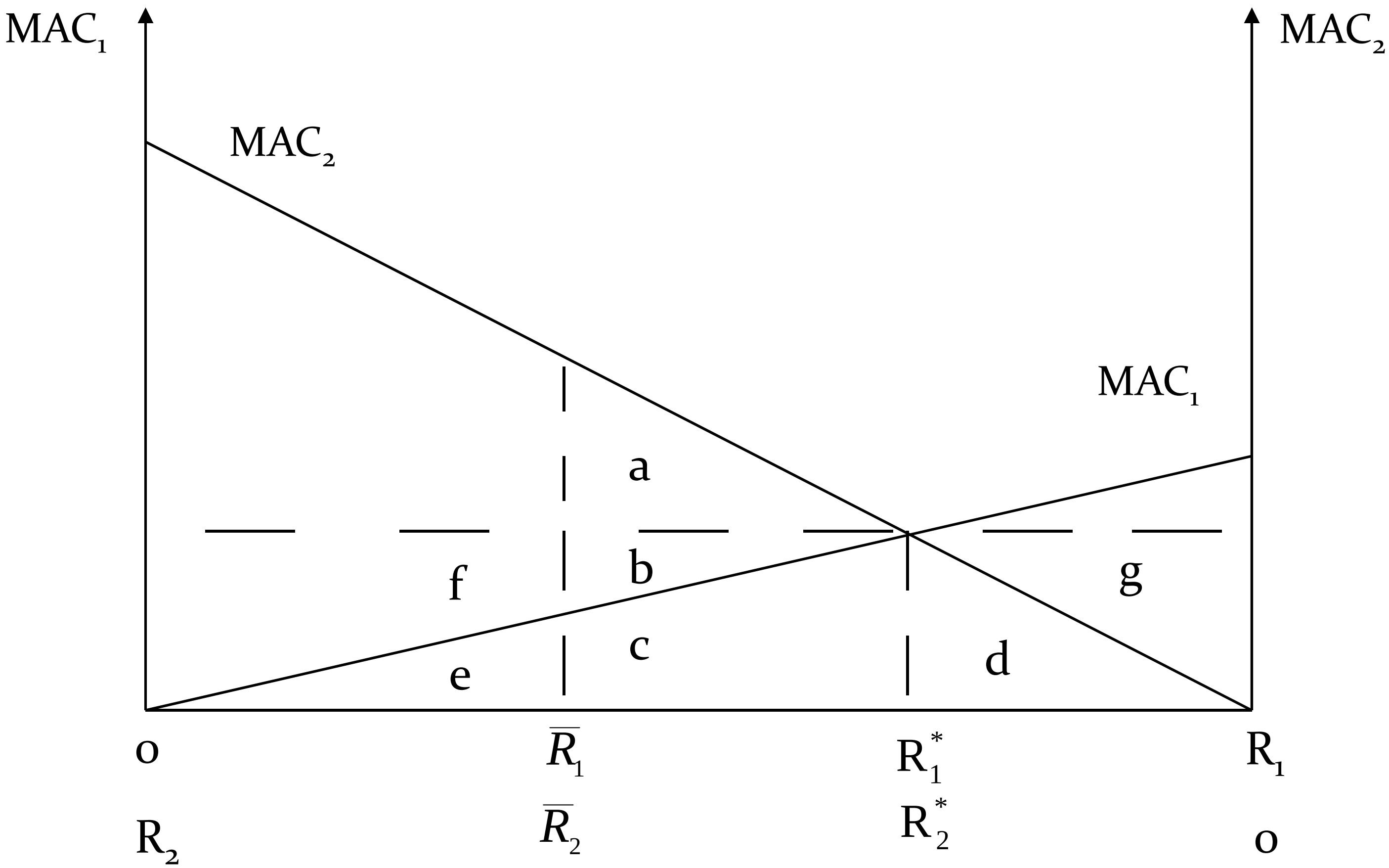


# Command and control




- At $R_1 = R_1^*; R_2 = R_2^*$ total costs are $c + d + e$

## Command and control




- At $R_1 = \overline{R}_1; R_2 = \overline{R}_2$ total costs are $a + b + c + d + e$: inefficient!

## Command and control

- So CAC does not meet requirement of static efficiency
- Neither is it dynamically efficient:
  - Suppose all (new) firms are required to use technology X
  - Then why develop a technology that is cleaner?

## Command and control

Why have CAC policies been used so often? Advantages of command and control:

- Very effective: past experience shows succesful reduction in emissions of many pollutants
  - But at higher total costs than with use of efficient instrument
- Politically attractive: firms prefer CAC to taxes and permits
  - Because technology standards produce economic rents for firms;
  - Rents can be sustainable if coupled with more stringent requirements for new sources: entry deterrence!
  - With auctioned permits or taxes, firms pay abatement cost *and also* costs of emitting up to that level.

## Command and control

Can CAC play a role in climate policy?

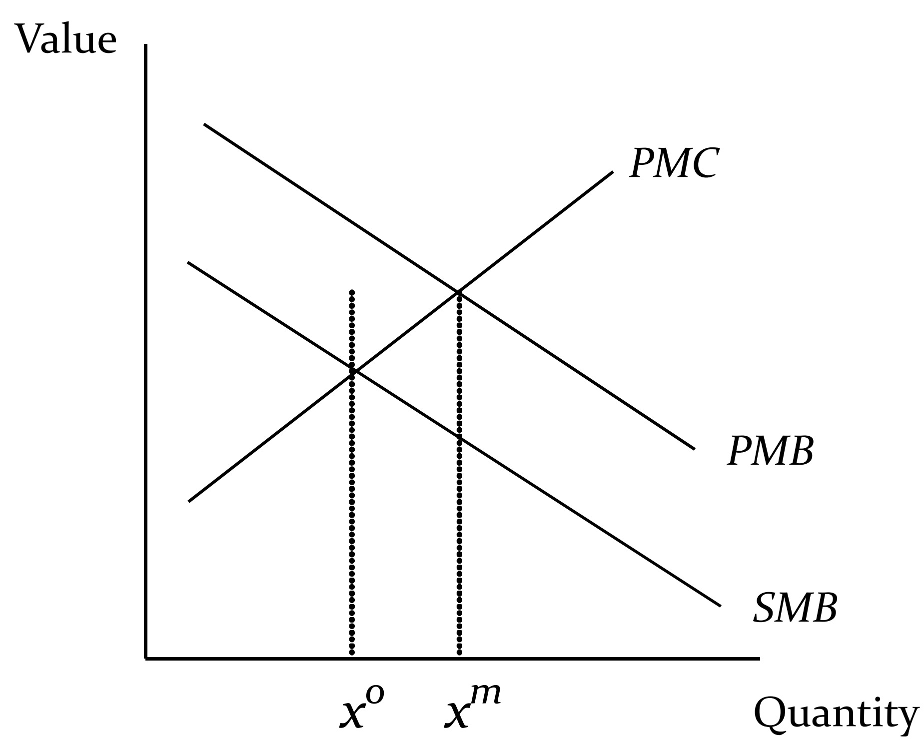
- Many industries face cap-and-trade system (next week)
- But what about consumers? Transport sector? Service industry?
  - Often hard to reduce emissions (service sector)
  - Too many consumers to monitor $CO_2$ emissions
- Technology standards as well as output targets are and will be used:
  - Transport sector: car industry has to meet requirements for cars produced
  - Consumers: ban on sale of ‚normal' light bulbs
  - Consumers; service industry: energy labelling on electronic devices

## Pigovian taxation

- Externalities cause inefficiency because of the divergence between social and private benefits or costs
- With a *negative* externality, a tax can be used to raise the private marginal cost (or a subsidy on emission reductions can be introduced)
- With a *positive* externality, a subsidy can be used to reduce the private marginal cost
- If the tax is set at the level equal to the marginal damage caused by an externality, then the tax is a Pigovian tax

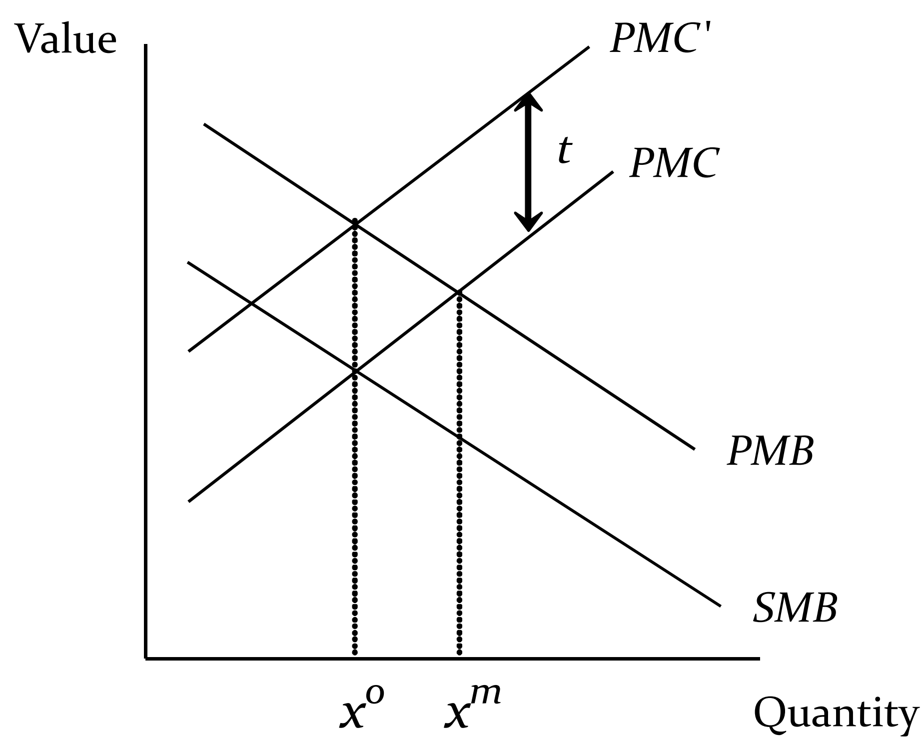
# Pigovian taxation

- Example: correction of a *negative* consumption externality
- Social marginal benefit (*SMB*) is below Private marginal benefit (*PMB*)
- $x^m$ is market outcome
- $x^o$ is Pareto efficient with $SMB = PMC$



## Pigovian taxation

- Example: correction of a *negative* consumption externality
- Social marginal benefit (*SMB*) is below Private marginal benefit (*PMB*)
- The tax, *t*, raises Private marginal cost from *PMC* to *PMC'*
- The quantity consumed falls from $x^m$ to $x^o$
- $x^o$ is efficient with *SMB* = *PMC*



## Pigovian 'tax': A simple example

- Consider once more the windmill farmer and the winery
- Positive externality!
- See blackboard

## Pigovian taxation: A slightly more complicated case...

- Consider two consumers (index *h=1,2*) with utility functions

$$U^1 = x^1 + u_1(z^1) + v_1(z^2)$$

$$U^2 = x^2 + u_2(z^2) + v_2(z^1)$$

- Externality arises from consumption of good *z*
- For $v_h'(.) > 0$ we have a positive externality
- For $v_h'(.) < 0$ we have a negative externality
- Assume that $p_x=p_z=1$ and that agents have income *M*
- Then budget constraint requires: $x^h = M-z^h$

# Pigovian taxation

$$U^1 = x^1 + u_1(z^1) + v_1(z^2) \qquad U^2 = x^2 + u_2(z^2) + v_2(z^1) \qquad x^h = M\text{-}z^h$$

- Competitive equilibrium:

$$\max U^1 = M - z^1 + u_1(z^1) + v_1(z^2)$$

$$\frac{\partial U^1}{\partial z^1} = 0 \Rightarrow -1 + \frac{\partial u_1}{\partial z^1} = 0 \Leftrightarrow \frac{\partial u_1}{\partial z^1} = 1$$ Private marginal benefit cons 1

Similarly for consumer 2:

$$\frac{\partial U^2}{\partial z^2} = 0 \Rightarrow -1 + \frac{\partial u_2}{\partial z^2} = 0 \Leftrightarrow \frac{\partial u_2}{\partial z^2} = 1$$ Private marginal benefit cons 2

## Pigovian taxation

- Social optimum (Pareto efficient allocation) with equal welfare weights: W = U1 + U2

$$\max W = M - z^1 + u_1(z^1) + v_1(z^2) + M - z^2 + u_2(z^2) + v_2(z^1)$$

$$\frac{\partial W}{\partial z^1} = 0 \Rightarrow -1 + \frac{\partial u_1}{\partial z^1} + \frac{\partial v_2}{\partial z^1} = 0 \Leftrightarrow \frac{\partial u_1}{\partial z^1} + \frac{\partial v_2}{\partial z^1} = 1$$

Social marginal benefit from $z^1$

$$\frac{\partial W}{\partial z^2} = 0 \Rightarrow -1 + \frac{\partial u_2}{\partial z^2} + \frac{\partial v_1}{\partial z^2} = 0 \Leftrightarrow \frac{\partial u_2}{\partial z^2} + \frac{\partial v_1}{\partial z^2} = 1$$

Social marginal benefit from $z^2$

- Compare with private (or 'market') outcome:

$$\frac{\partial u_1}{\partial z^1} = 1 \qquad \frac{\partial u_2}{\partial z^2} = 1$$

## Pigovian taxation

- So far: consumer price equals producer price which is equal to 1
- FOC for consumer U max imply marginal utility = consumer price
- Idea: Can we set the consumer price, say $q_h$, such that social optimum is result of 'marginal utility equals consumer price'?
- Social optimum:

$$\frac{\partial W}{\partial z^1} = 0 \Rightarrow \frac{\partial u_1}{\partial z^1} + \frac{\partial v_2}{\partial z^1} = 1 \Rightarrow \quad \frac{\partial u_1}{\partial z^1} = 1 - \frac{\partial v_2}{\partial z^1} \equiv q_1$$

$$\frac{\partial W}{\partial z^2} = 0 \Rightarrow \frac{\partial u_2}{\partial z^2} + \frac{\partial v_1}{\partial z^2} = 1 \Rightarrow \quad \frac{\partial u_2}{\partial z^2} = 1 - \frac{\partial v_1}{\partial z^2} \equiv q_2$$

- The difference between the consumer price needed to reach the social optimum and the producer price is the Pigovian tax $\tau_h$:

$$\tau_1 = q_1 - 1 = -\frac{\partial v_2}{\partial z^1} \quad , \quad \tau_2 = q_2 - 1 = -\frac{\partial v_1}{\partial z^2}$$

Note: in general $\tau_1 \neq \tau_2$!

## Pigovian taxation

- Pigovian taxation appears a simple solution: a price is set on the externality
  - A tax is paid equal to the marginal damage
  - A subsidy is received equal to marginal benefit
- However, for Pigovian tax
  - In general taxes need to be differentiated between consumers, firms, and goods
    (depending on the particular externalities they cause)
  - Even when MD same for all agents, government needs to know that marginal damage to set correct Pigovian tax
- BUT: for ANY target level, a tax is an efficient instrument
  - For given tax, firms will adjust emissions until MAC equal tax: MAC equalized over all firms, hence tax cost-effective

# Taxation

- Tax income can be used to lower distorting taxes
(e.g. taxes on labor income with distortion of offering less labor)
  - Weak double dividend hypothesis:
  non-environmental welfare loss due to environmental tax is lower if tax income is used to lower distorting tax on e.g. labor income
  (compared to case where they are recycled in a lump-sum fashion)
  - Strong double dividend hypothesis:
  environmental tax not only improves environmental quality but also non-environmental welfare

## Taxation

- Dynamic efficiency of emissions tax:
  - If a firm has to pay $t$ per unit of emissions, then an emission reduction always means less tax payments
  - Gives incentives to develop (or adopt) a new technology that reduces emissions (for current emission levels) at lower costs ($MAC < t$)
- Ecological accuracy:
  If there is uncertainty in MAC, then given tax leads to uncertain emission reduction
- Political feasibility:
  With taxation, large transfers of money: if target is to reduce emissions by 10%, still taxes are paid over 90% of initial amount –> firms are hostile to taxes

## Subsidies

- Economists are in favor of market-based instruments like tax. Subsidy is negative tax.
- Is subsidizing 'good behavior' efficient? (emission reductions, or particular technologies like solar panels, windmills)
- Political feasibility: yes!! Firms love subsidies!
- But less desirable in terms of efficiency:
  - Have to be financed through distorting taxes
  - Hard to stop once started
- In case of subsidy on particular technology: dynamically inefficient:
  - Does government know which technology is best?
  - Hampers technology competition