TOPICS IN CAP-AND-TRADE

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PASTURE 1: THOUGHTS ABOUT THE POWER PLANT VISIT

What was interesting to you about the visit?

Review the emissions control regulations the plant is subject to:

-Gas turbine is in NOx Budget

-NSPS: MACT/BACT for the NOx emissions from their boilers.

-Entire facility subject to 25 tpy state rule for NOx, probably for others.

Technologically, how much flexibility could the plant have to reduce emissions?

-Low NOx burners vs. buying a new boiler vs. SCR vs. air recirculation.

-The costs are heterogeneous across plants – SCR not possible.

-Heterogeneity in return to LNBs depends on capacity factor of the boilers.

From a regulatory perspective, how much flexibility does the plant have?

-Prescriptive CAC regulations for everything other than

Should the steam production be covered in cap-and-trade?

-If the gas turbine is, then you'd think the boilers should be because they emit more and there is more heterogeneity in how to reduce emissions from a boiler.

-But you might argue that this site is relatively small, and the transactions costs of adding a site are large (the CEMS and trading costs), so you could just mandate BACT and stop.

PASTURE 2: SPATIAL DIFFERENTIATION

Pollution concentration at Receptor j:

$p_j=\Sigma_i a_{ij} e_i + B_j$

Transfer coefficient: $a_{ij}=\Delta p_j/\Delta e_i$

What assumption being made?

Transfer coefficient is linear

Marginal damages from emissions from site i, or from ambient pollution p originating from site i:

$MDE_i=a_i MDA(p)$

What is efficient? Set marginal benefit from emissions = marginal damage from emissions at each i:

$-MC_i(e_i)=MDE_i=a_i MDA(p)$

Where MC = marginal costs of emission abatement.

Rewriting:

$MC_i/a_i=-MDA(p)$

And this holds for all sites i.
So we need two conditions for efficiency:

1. Marginal costs of abatement normalized by a must be equal for all sources
2. These must equal the (negative) marginal damage

What tax do we set?
The firm will abate to the point where MC=τ.
So set $\tau_i = a_i MDA(p)$

Graph: Losses from not having spatial differentiation: again, the slopes of the MD and MC curves matter!

Two firms, different marginal damages from emissions

Question: why do we have undifferentiated programs?

-Complexity
-Uncertainty about transfer coefficients
-Political feasibility

How to translate to an emissions trading program?

e.g. proposed zonal SO2 program

Temporal variability:

e.g. summer NOx program
NOx damages vary at a finer level.

<u>Multiple receptors</u>

Question: What if we have multiple receptors?

Hand out an appropriate number of permits for each receptor and have separate trading programs

Do all the trading programs need to bind?

No. This is what's happening with SO2 under the new rules.
Also, under NOx, there is an annual NOx program and a seasonal NOx program.

PASTURE 3: LEAKAGE

Motivation
Draw product market graph.

PASTURE 4: STOCK POLLUTANTS

A pollutant accumulates according to $s(t)=\delta s(t-1) + e(t)$

$s(t)$=stock at time t

$e(t)$=emissions at time t

δ=persistence rate

Question: What does δ mean?

$\delta=1$ => never degrades

$\delta=0$ => degrades immediately

Question: what are pollutants with $\delta=1$ and $\delta=0$?

Push question: Are any pollutants pure stock or pure flow?

(No)

Can we order pollutants from flow to stock?

- Particulates
- NOx
- Acid Rain precursors
- CO2
- CFCs
- Radioactive waste

Total costs of pollution:

(Start at t=1 and aggregate):

$C_{total}=\Sigma\beta^{t-1}(D_t(s_t))$

Marginal damage:

$dC/de=ds_t/de \cdot MD_t(s_t)$

How do we get ds/de?

$s_t=e_t+\delta e_{t-1}+\delta^2 e_{t-2}+\ldots+\delta^{t-1}e_1+\delta^t s_0$

Change in the stock at t from a one unit of emissions in the present (t=1):

$Ds_t/de_1=\delta^{t-1}$

Total Marginal damages from one unit of emissions in the present:

(Sum over all t's)

$MD_{total}=\Sigma_t\beta^{t-1}\delta^{t-1}\cdot MD_t(s_t)$

Can see that if T=1, then $MD=MD_t(s_t)$

For T>1, discount the future by β (rate of time preference) and δ (the decay of the emissions)

For the optimal level of emissions, set Marginal Damage=Marginal Savings

DYNAMIC UPDATING

Theoretical example:

$d\pi_j/dE_{1j}=\alpha - \beta E_{1j} - \tau_1 + dA_2/dE_1 \cdot \tau_2$

Optimum:

$\alpha - \beta E_{1j}=\tau_1$

$E^*_{1j}=(\alpha - \tau_1)/\beta$

Equilibrium under dynamic updating:

$\alpha - \beta E_{1j}= \tau_1 - dA_2/dE_1 \cdot \tau_2$

$E^*_{1j}=(\alpha - \tau_1 + dA_2/dE_1 \cdot \tau_2)/\beta$

** Every firm is going to try to over-emit, so that they can get more allowances in the second period

** Draw graph with MB shifted out by amount $+dA_2/dE_1 \cdot \tau_2$

Question: Is this a problem?

The cap will keep emissions at E_T

So we don't have any *extra* emissions.

But are the emissions misallocated?

Solve for allowance price:

$E_T=\Sigma_j E_j$

$=N \cdot (\alpha - \tau_1)/\beta + N \cdot dA_2/dE_1 \cdot \tau_2$

$\tau_1^*= \alpha - \beta E_T /N + dA_2/dE_1 \cdot \tau_2$

Plug this into each firm j's emissions for period 1:

$E^*_{1j}=(\alpha - (\alpha - \beta E_T /N + dA_2/dE_1 \cdot \tau_2) + dA_2/dE_1 \cdot \tau_2)/\beta$

$=E_T /N$

So is there no inefficiency?

Refer to graph.

$E^*_{1j}=\alpha/\beta + (dA_2/dE_1 \cdot \tau_2 - \tau_1) / \beta$

The first period allowance price goes up by an amount that offsets each firm's incentive to over-emit.

What inefficiencies does this generate?

1. Allowance price too high => product market prices may be too high
2. When borrowing is allowed, there will be over-emission in the first period.

Takeaways:

1. Dynamic updating raises the allowance price in the first period but does not distort emission abatement.

2. This does, however, distort input prices and thus product market prices
3. But when firms can borrow allowances from the second period, there will be over-emission.

Potential exam question: Show the conditions under which dynamic updating of allowance allocations leads to inefficiency

HYBRID PRICES AND QUANTITIES: SAFETY VALVES

Use the example on page 315.

OTHER ISSUES

Market power.

Question: What happens if there is a firm with market power in the allowance market?

If firm is a net seller of permits at equilibrium price, it withholds permits, underabates, and pushes the price up.

If firm is a net buyer of permits at equilibrium price, it buys too few, overabates, and pushes the price down.

So market power is a worry if there is a dominant firm

Business importance of certainty

This in my mind is a primary argument for emissions taxes over cap-and-trade.

TAKEAWAYS

Question: When do we prefer cap-and-trade vs. taxes vs. CAC?

	CAT	Tax	CAC	Notes
Large group of emitters	Yes			Liquid market
Concentrated group of emitters	No			Market power
Spatial differentiation in damages			Yes	CAT/Tax political feasibility
Abatement cost heterogeneity				Equimarginal Principle
Emissions costly to observe	No	No	Yes	Tech standard, e.g. cars
Property rights difficult to enforce	No			David Victor/Kyoto
Each site pollutes a lot				
"Pollution > transaction costs"				
Distortionary labor taxes	Yes	Yes	No	CAT yes if auction Uncertain
marginal costs of abatement				
Marginal damages more steeply	Yes	No		
sloped than marginal savings				
Marginal savings more steeply				
Sloped than marginal damages	No	Yes		
Leakage				
Technology developed by plants	Yes	Yes	No	Stifles plant innovation
Technology developed by vendors			Yes	BACT guarantees market
Regulator has poor info on abatement tech			No	

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