PIGOUVIAN TAXES

14.42 LECTURE PLAN 5: FEB 15, 2011

Hunt Allcott

PASTURE 1: OPTIMAL PIGOUVIAN TAX

Return to electricity and tourism example

LEFT BOARD 1: ELECTRICITY FIRMS: MARGINAL BENEFIT OF POLLUTION

Two different firms

$\pi_{w1} = p_W W - (1/2W^2 + \tau E + F)$

$\pi_{w2} = p_W W - (1/4W^2 + \tau E + F)$

E=W

What's interesting about these production functions?

-The only way to abate emissions is to reduce output.

Easy question: which firm is more efficient? What mechanically generates this? (age, proximity to low-sulfur coal, etc)

<u>Solve for marginal social benefit</u>

Take out τ

Substitute E for W

Could draw profits as a function of emissions here.

Take derivative

Draw $d\pi/dE$ on graph. This is marginal benefit

How to get social marginal benefit? Aggregate horizontally or vertically?

"Production of emissions" is rival here: two firms can't emit the same unit of pollution

So rewrite with E on left hand side

Then get: $\Sigma E = 3p_W - 3d\pi_w/dE$

Total social marginal benefit of emissions: $d\pi_w/dE_{Total} = p_W - E_{Total}/3$

RIGHT BOARD 1: TOURISM FIRMS: MARGINAL COST OF POLLUTION

$\pi_{t1} = p_T(10 - E^2/2) - C$

$\pi_{t2} = p_T(10 - E^2) - C$

<u>Solve for marginal social cost of emissions</u>

Take derivative

$d\pi_{t1}/dE = -p_T E$

$d\pi_{t1}/dE = -2p_T E$

Draw each firm's marginal cost from pollution

How to aggregate? Are emissions rival or non-rival?
$d\pi_t/dE = -3p_tE$
Question: This is the change in profits. Is this a marginal cost?
Need to change the sign:

Marginal cost of Emissions = $3Ep_t$

<u>Solve for the Optimum</u>
Two ways to do this:

1. Max profits combined in both industries
2. Set MC=MB.

Set MC = MB.

This looks a lot like the Samuelson Condition:

$\Sigma_i MRS_i(G^*)=MRT(G^*)$

$E^*=p_w/(3p_t+1/3)$

Diagnose why p_w in the numerator and p_e in the denominator.

Set $p_w=1$ and $p_t=2/9$
Draw MC and MB on board:
$E^*=1$
MC=MB=2/3

LEFT BOARD 1 OR 2:
<u>How the optimal pollution tax works</u>
Show that a tax of $\tau=2/3$ gives emissions of 1/3 and 2/3 for the two firms.

<u>Compare to Command and Control</u>
Now compare this form of abatement to a CAC policy where each firm emits E=1/2.

Old firm abates less under tax
New firm abates more under tax.
Overall social welfare gain is positive.
Distributional impacts can be dealt with through how we recycle tax revenues?

PASTURE 2: ENTRY AND EXIT
Change slide to intro this question.

Two stages:

1. Firms decide whether to exit
2. Firms set optimal quantity

<u>Solve via backwards induction</u>
Solve for W*(τ*=2/3)
W_1*=1/3
W_2*=2/3
F=1/10

Form a table for Firm 1 (the old inefficient firm):

	No recycling (social value)	Recycling if stay only	Guaranteed recycling
πstay:	-.04444	.2889	.28889
πexit:	0	0	1/3

Similar story with entry: Do we recycle pollution tax revenues to entrants? No – it's like a subsidy to entry.
Story with subsidies: subsidies discourage exit and encourage entry into polluting industries, relative to the tax.

Subsidies also must come from somewhere, and there is a dwl from taxation.

PASTURE 3: MARKET POWER

PASTURE 4: DOUBLE DIVIDEND
Revenue Raised from emissions tax: τ*E*
<u>Recycling Effect:</u>
RE = V*(Revenue Raised) = V*τ*E*
V = Marginal DWL taxation ≈0.4

<u>Interaction Effect</u>
1. Price of the polluting good X goes up
2. The good is a substitute for leisure
3. Leisure goes up
4. Labor mechanically is distorted further down
5. Labor tax revenues decrease
6. Must make up the tax revenues with additional labor taxes.

IE=(1+V) $t_L \Delta L$ = (1+V) $t_L \Delta p_x$ dL/dp_x

14.42 / 14.420 Environmental Policy and Economics
Spring 2011