PASTURE 1: AUDITS AND ENFORCEMENT

- Begin with Ecuador/Chevron vignette.

Left Board 1: Model 1
The government cannot perfectly monitor, but it can audit. How does the firm respond?

$\pi = (p_Y - c_Y) Y - C(e) - F(e)$
Y = output
e = emissions
π = Audit probability
f = Fine per unit of emissions

- Notice that the profit function is separable in emissions and output

Regulator: set fine equal to amount of emissions
$F = \pi e f$

What will the firm do?
$d\pi/de = 0 \Rightarrow -C' = F' = \pi f$

Social optimum:
$-C' = \pi f = MD(e^*)$

So the regulator sets $F' = \pi f$ at the level of marginal damages. So $F = \pi e f$
  Intuitively, if $\pi = 1$, then f = Pigouvian tax. This is just a Pigouvian tax paid with probability<1.

Question: Why not do this?
Push question: I have just showed you how we can save a ton of money on enforcement. What's the problem?
Answer: fairness: this ends up being a capricious environmental policy: you're only subject to it if you are unlucky.

Right Board 1: Model 2
Regulator sets a standard, denoted s

Now the fine is:
$F(e) = \quad \pi[f(e-s) + D] \quad$, if e>s
$\qquad 0 \quad$, if e≤s

- Draw the high-fine corner solution and the low-fine interior solution

Question: Should we set π high or f high?
Auditing comes with a cost – so set f high?
What limits this?
- Fairness (perceived by firm and public)
- Firm value – can't fine more than the assets of the firm

Question: Some empirical research has shown that firm behavior is insensitive to the fine
Push question: Is the fine to the regulator the only cost of being caught?
- CAFÉ example: American automakers don't want to violate the standard
- Oil company example: stakeholder pressure – oil companies don't want to look bad with environmental violations.
So this means that we should want π high.

Question: Kolstad says:
"Clearly if the standard is s, then πf should be set so that [the firm's profit maximum] is satisfied at s"
$C'(s) = \pi f$.

Question: Is this right?
Push question: Where did s come from? Is the objective to have adherence to a standard or to achieve the social optimum?
Answer: It should be the social optimum. If s is the social optimum, then any $\pi f \geq C'$ gets either an interior or corner solution at $e* = s$.

But what if: The regulator doesn't know C? (as in much of the first half of the semester!)
Then set a standard that we think is less stringent than optimal, set πf=Marginal Damages, let firms choose how much to violate, expect violations, but then arrive at the social optimum.

What other ways to reduce audit costs but still keep compliance?
- Self-reporting violations. This helps catch minor environmental violations. (e.g. power plants, NCAA sports)
- Target audits at past violators. This both focuses on companies that are more likely to audit in the future and also decreases violations in the present.
  - Talk through what this model looks like: a two-period model where my audit probability next period depends on whether I am found in violation this period. This increases my chance of compliance in this period. See model below.

Optional Model: Two Periods with Endogenous Audit Probability

This shows the additional deterrent effect:

$$\pi = (p_{Y1} - c_{Y1}) Y_1 - C(e_1) - F(e_1, \pi_1, f) + (p_{Y2} - c_{Y2}) Y_2 - C(e_2) - F(e_2, \pi_2(e_2), f)$$

$$d\pi/de_1 = 0 \Rightarrow -dC(e_1)/de_1 = dF(e_1, \pi_1, f)/de_1 + dF(e_2, \pi_2(e_2), f)/d\pi_2 \cdot d\pi_2/de_1$$

PASTURE 2: COMMITMENT

Return to a world where the regulator can enforce a regulation in this period, but cannot commit to whether the regulation will be in place next period.

Say that there are two levels of regulation: Tight and Weak

And two ways of complying: Short-Run and Long-Run.

Two period game

The regulator imposes Tight regulation in P1 and Tight with probability ϕ in P2.

- Draw game tree

The Short-Run compliance strategy is better if P2 Regulation is Weak but worse if Regulation is Tight.

- SR: $30 if Weak, $60 if Tight
- LR: $50 regardless

Example: scrubbers vs. fuel switching.

Example: reinjection of drilling fluid vs. surface treatment

Question: What does the firm do in P1?

Answer: Firm chooses Short-Run strategy if $\phi < 1/2$.

Takeaway:

Without uncertainty, Weak regulations cost $30 per year and Tight regulations cost $50 per year. With uncertainty and $\phi < 1/2$, every year of Tight regulation is not in between those two: it's more! $60 per year.

Implications:

- In a country that can't commit, the optimal level of regulation may be weaker than in a country that can commit! This is because lack of commitment increases compliance costs because firms focus on short-run compliance strategies.
- Extension: The Ratchet Effect. A country may want to retain flexibility, but this causes nobody to invest, which increases compliance costs in the future, which makes it less plausible that the firm will choose stringent regulation in the future.
    - Self-fulfilling prophecy of fear of weak regulation
    - Example: ZEV program, auto emission standards

PASTURE 3: CLEAN WATER
Opening question: What did you think was interesting?

<u>Left Board 3: Takeup</u>
Question: In-home chlorination costs $40 per DALY – it's a remarkably cheap way to make yourself better off. Why don't people do it?
- Intra-household bargaining: the men make decisions, while women and children prefer cleaner water.
- Information? But in the Kremer et al. (2010) paper, 70-90 percent of people know about point-of-use chlorine and 70% know that drinking dirty water is the problem. Yet only 5-10% chlorinate.
- Salience – we know, but it's not salient in our decisions.
- Channel factors: small transport costs make a big difference
- Other factors not covered:
  - Biased beliefs
  - Unaccounted costs: e.g. chlorine makes water taste different

Notice that you'll see this coming up a lot: cookstoves, fertilizers, energy efficiency, tooth flossing.

<u>Right Board 3: The Case for Policy Intervention in Water Quality</u>
Is government intervention appropriate?
- Public interest theory of environmental regulation: Recall the First Welfare Theorem and regulate only to correct a market failure.
- Also equity arguments

What market failures?
- Externalities in disease transmission
- Intrahousehold bargaining
- Behavioral failures: people are themselves not optimizing

What equity issues?
- This is a way of transferring resources to the poor. But why not just give them money and let them spend it? Intervention to provide clean water has to come back to one of the above market failures.

What policies available?
- Direct provision (e.g. gov't or NGOs supply chlorine at the tap or to houses or in health clinics)
- Information
- Subsidies
- Or combinations of the above

Which policies appropriate for which market failures?

- If externalities are the main market failure and externalities equal across people, just subsidize and we get the first best.
- Information might not work if intra-household bargaining or externalities are the key problems.

14.42 / 14.420 Environmental Policy and Economics
Spring 2011