

**THE PORTER HYPOTHESIS**  
 14.42 LECTURE PLAN 12: APRIL 5, 2011  
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**PASTURE 1: PRODUCTIVITY**

Left Board 1

Production function (at the firm level or economy level):

$$Y = A \cdot f(K, L)$$

Y = Output

A = total factor productivity

K = Capital

L = Labor

Question: How can we decompose a change in output?

Take total derivative:

$$dY = dA \cdot f(K, L) + A \cdot df/dL \cdot dL + A \cdot df/dK \cdot dK$$

- $A \cdot df/dL = MPL$ , so

$$= dA \cdot f(K, L) + MPL \cdot dL + MPK \cdot dK$$

Dividing by  $Y = A \cdot f(K, L)$ :

$$dY/Y = dA/A + (MPL/Y) \cdot dL + (MPK/Y) \cdot dK$$

- Multiply last two terms by  $L/L$  and  $K/K$

$$= dA/A + (MPL \cdot L/Y) \cdot dL/L + (MPK \cdot K/Y) \cdot dK/K$$

- At zero profits:  $MPL \cdot p_Y = p_L$ ,  $MPK \cdot p_Y = p_K$ 
  - (You can get this by setting up the profit max LaGrangian with zero profits:
  - $\pi = p_Y f(K, L, E) - p_K K - p_L L + \lambda(Y - Af(K, L))$
  - Then take derivative wrt K or L and notice that  $\lambda = p_Y$

$$= dA/A + p_L \cdot L / (p_Y \cdot Y) \cdot dL/L + p_K \cdot K / (p_Y \cdot Y) \cdot dK/K$$

- $s_K = p_K \cdot K / (p_Y \cdot Y) = \text{Cost share of Capital}$

$$= dA/A + s_L \cdot dL/L + s_K \cdot dK/K$$

- Rewrite with TFP growth on LHS:

$$dA/A = dY/Y - s_L \cdot dL/L - s_K \cdot dK/K$$

Question: Why do we like TFP growth?

Question: How to show the bias in TFP growth from ignoring environmental inputs?

Add environment:

$$dA/A = dY/Y - s_L \cdot dL/L - s_K \cdot dK/K - s_E \cdot dE/E$$

What are examples of using the environment more or less intensively?

- More intensively: natural resource extraction
- Less intensively: air pollution and electric power (from Kolstad book)

Induced innovation: When environmental (or other factor) price increases, firms innovate (and substitute) to reduce  $s_E$ . Give examples:

- Pollution regulations => new pollution control technologies
- Energy: High energy prices => hybrid cars

## PASTURE 2: UNDERSTANDING THE PORTER HYPOTHESIS

### Right Board 1

Question: What is the Porter Hypothesis?

Push question: Are there different levels of the Porter Hypothesis? Strong vs. weak?

Answer: I (Hunt) think that there are two different versions of the Porter Hypothesis:

- a. Weak: Policy should be designed to encourage innovation, and thus reduce compliance costs
- b. Strong: Environmental regulation can have negative compliance costs

Question: What justifies the Porter Hypothesis? Market failures lead to inefficiencies

- Incomplete information
- Organizational inertia
- Agency problems within firms

## PASTURE 3: EVALUATING THE PORTER HYPOTHESIS

### Left Board 2: Arguments against:

*Theoretical argument (Board 3)*

$$\max_{K,L,E} \pi = p_Y f(K,L,E) - p_K K - p_L L - p_E E$$

$$\pi^* = p_Y f(K^*,L^*,E^*) - p_K K^* - p_L L^* - p_E E^*$$

$$K,L,E \geq 0$$

Question: How can I use this to show that the Porter Hypothesis can't be right?

Push question: What does environmental regulation do in this model?

1. Increases price of the environment factor

## 2. Or adds a constraint

Two ways of conceptualizing an environmental regulation:

*Increase price of the environment:*

$d\pi^*/dp_E < 0$  if  $E > 0$  and (by Envelope Theorem) ignore re-optimization of  $E^*$

*Add an environmental constraint:*

$\max_{K,L,E} \pi = p_Y f(K,L,E) - p_K K - p_L L - p_E E \quad \text{s.t. } E \leq E_{\max}$

Gives  $\pi'(K',L',E')$

$\pi' < \pi^*$ , unless  $E' = E^* \leq E_{\max}$

Either way, mechanically, firms have to be worse off under the constraint.

Question: How can we modify this model?

Answer: The firm has to be off of its optimum.

And stronger than that: On average, firms have to be off of their optima.

Or make dynamic, but the firm then has to be off of its dynamic optimum.

### *Empirical evidence*

Porter's evidence largely anecdotal. There is a huge difference between arguing that some firms are making mistakes and arguing that firms are systematically making mistakes that would be fixed by a particular form of regulation.

POP empirical evidence: \$2 billion in offsets for \$102 billion in environmental costs

### *Upfront costs*

What are the upfront costs? Only discussed in some cases. E.g. Robbins company ended up with a better process, but how much did this cost? E.g. Hitachi example – no sense of whether reduced parts actually reduced costs, or how much it cost to research the new process or develop the new assembly line.

Page 100: "More stringent regulation, however, focuses greater company attention on discharges and emissions . . ." Does this attention have costs? Perhaps it detracts from other innovation activities that could have higher returns.

### *Directly fix the market failures*

Porter points to imperfect information and intra-firm problems as reasons why firms may be making mistakes. Why not try to solve the information problems instead of regulating?

Question: is there any sense that the market failures tend to lead to too much pollution?

*Is this unique to environmental regulation? Any sort of regulation could do this?*

*Autonomous improvements are not the same as regulation-driven improvements*

In some cases, these are examples of efficiency improvements that happened autonomously without regulation that had incidental environmental/waste benefits. There is a huge difference between arguing that efficiency gains reduce pollution and that pollution control laws increase efficiency.

Right Board: Arguments for the Hypothesis

Question: Are there any ways in which the Porter Hypothesis could be right? That regulation could increase profitability?

*>100% Pass-through to consumers*

EU ETS. More than 100% pass-through

*Early-Mover Advantage in International Markets*

If the regulation anticipates future regulation in other countries and thus prepares firms more quickly for the product markets of the future. German packaging, Scandinavian pulp and paper, Cummins diesel example.

Question: What does this mean for carbon? Renewable energy?

Question: But U.S. companies can also recognize these international trends and respond! He argues that “regulators would seem to possess greater resources and information than firms for understanding the path of regulation in other countries.” It is not obvious that regulators are more enlightened than firms.

Question: do these first two increase social welfare? No – it’s just that regulation helps firms pass through costs in prices, or benefits some firms.

*Anecdotal evidence in the chemical industry.*

Page 105: “Fundamentally, [pollution] is a manifestation of economic waste and involves unnecessary, inefficient, or incomplete utilization of resources.” This may be true in chemicals, but it’s not true in electric power, for example. Same with CO2.

Takeaways:

1. Empirical evidence does not support the Porter Hypothesis
  - a. Porter’s own anecdotal evidence does not even support it!
  - b. But certainly there will be isolated cases where a regulation has improved productivity.
2. Requires firms that are mis-optimizing and regulators that are better informed.
3. There may be some cases where regulation can improve profits:
  - a. More than 100% pass-through (although this hurts consumers)
  - b. Lead international regulation

**POLICY IMPLICATIONS**

Right Board 3:

- Set clear goals with flexible approaches – let industry innovate.
  - Downside: technology mandates could help establish economies of scale or reduce uncertainties for abatement technology producers.
- Market-based regulation or taxes
  - How does this increase the incentives for innovation relative to the flexible plant-level emissions standard? Means that plants have the opportunity to monetize further improvements.
- Info programs – info on “innovation offsets” in other settings.
- How does publicly providing information make a difference?
  - Public pressure and also giving information on relative emissions (social inference)

Question: Do we disagree with any of these? Is there any difference between these and what we argued for before spring break, in terms of the equimarginal principle?

Push question: Is there any difference between why we argued for these before spring break and why we’re arguing for them now?

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Overall class takeaways:

1. Environmental regulations are not likely to be costless, and costs must be traded off against benefits.
2. But it is important to design policy to improve firms’ information and allow flexibility in compliance.
  - a. Flexibility both induces innovation (dynamic) and

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