The Pollution Haven Hypothesis

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What is the Pollution Haven Hypothesis?

Globalization causes polluting activities to concentrate in (poor) countries with weak environmental policy.

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1. Is pollution policy a source of comparative advantage?

2. Is pollution policy a *determining* cause of comparative advantage (at least in some sectors)

   - Do countries with weak environmental policy have a comparative advantage in polluting industry?

Why Does it Matter?

- Level and incidence of pollution around the world

- Competitiveness

- Carbon Leakage

- Green Countervail; Border Taxes

Definitions

Pollution Haven Effect   (Competitiveness Hypothesis)

- For given levels of trade barriers, weak environmental policy is a source of comparative advantage. Tightening up pollution policy reduces net exports or net incoming FDI in affected sectors.

Definitions

Pollution Haven Hypothesis (1)

- For given levels of environmental policy, liberalizing trade or foreign investment rules causes polluting industry (or firms / production facilities) to relocate to countries with weaker environmental policy

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- For given levels of environmental policy, liberalizing trade or foreign investment rules causes polluting industry (or firms / production facilities) to relocate to countries with weaker environmental policy

Pollution Haven Hypothesis (2)

- Tightening pollution policy in one country causes production of polluting industry (or firms / production facilities) to relocate to other countries with weaker environmental policy

Pollution Haven Effect: Theory

Simple case:

- Production-generated pollution

- No natural capital degradation
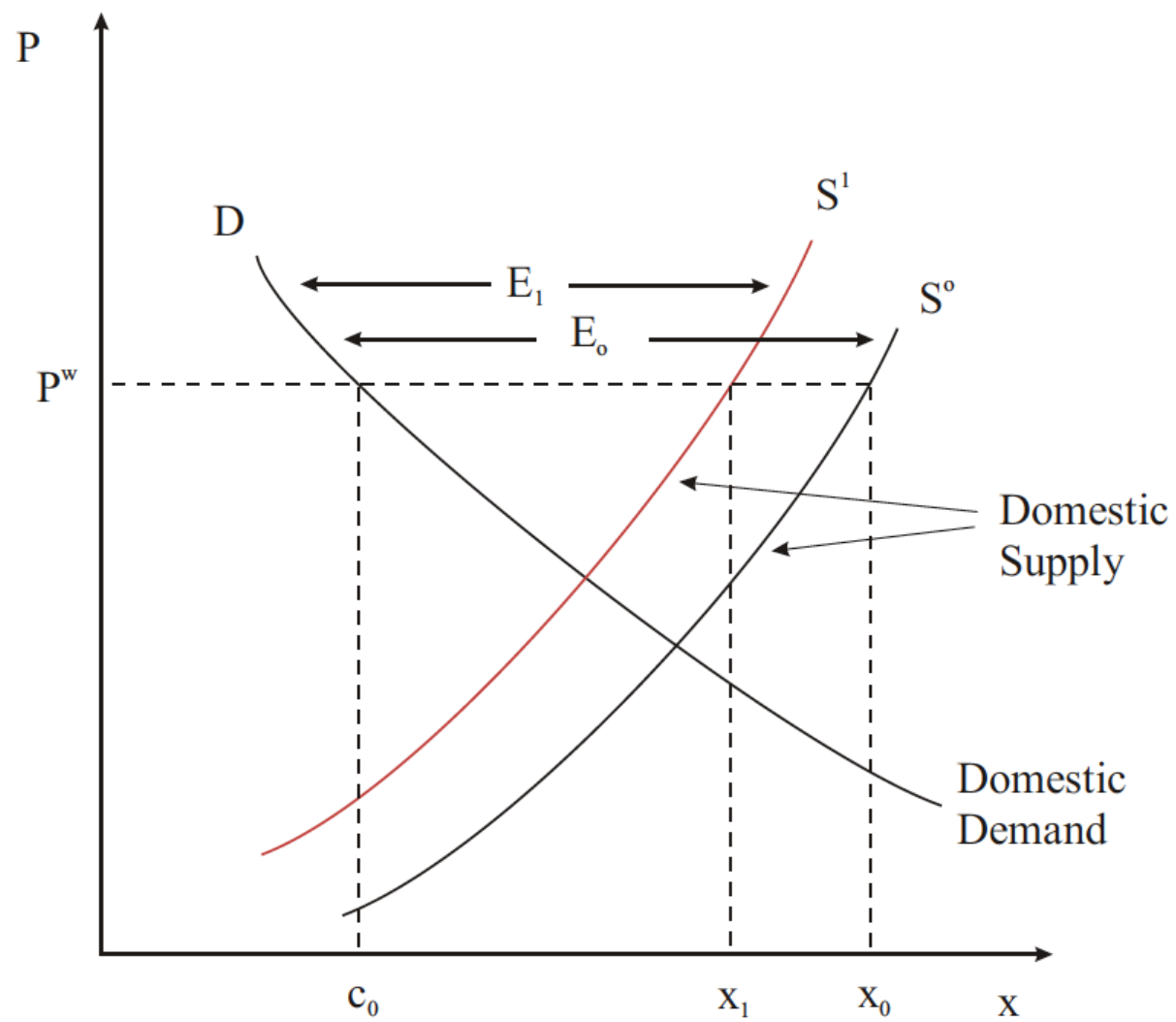
- Perfect competition

Figure 1. More stringent environmental policy
reduces competitiveness.

Robustness: Example

Energy (E) is produced from fossil fuel (F) and capital (K)

$$e = E(K_e, F_e)$$

X is produced from Labour and Energy and a fixed factor (T)

$$x = X(L_x, E_x, T)$$

Y is produced from capital and labour

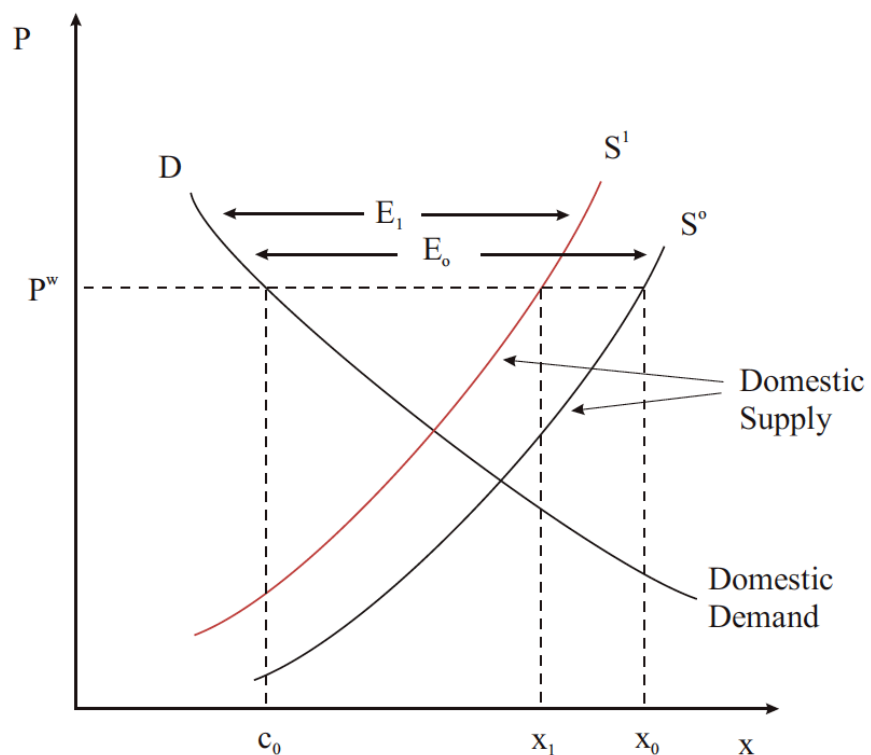$$y = Y(K_y, L_y)$$

Can find supply of X :

$$X^s(p_x, w, p_e, T)$$

Partial vs. General Equilibrium

$$X^s(p_x, w, p_e, T)$$

Suppose Fossil fuel is only source of emissions.

Emission tax raises price of energy (p_e) and if all else held constant, supply of X shifts left.

# But how does energy sector adjust to the tax?

$$e = E(K_e, F_e)$$

$$y = Y(K_y, L_y)$$

$$x = X(L_x, E_x, T)$$

- Emission tax on Fuel creates incentives to shift to alternative sources of energy (using capital).

- Capital drawn from Y, which releases labour as it contracts.

- This pushes down the wage and can allow X to expand.

- Chua (2003) on pollution havens; Karp (2010), Fullerton et al. (2011) on negative carbon leakage

How else could pollution haven effect fail?

- Porter Hypothesis

- Increasing returns in an upstream sector producing green input (McAusland 2004; Greaker)

- Directed Technical Change with Lock-in (Acemoglu et al. 2012)

- Consumption-generated pollution
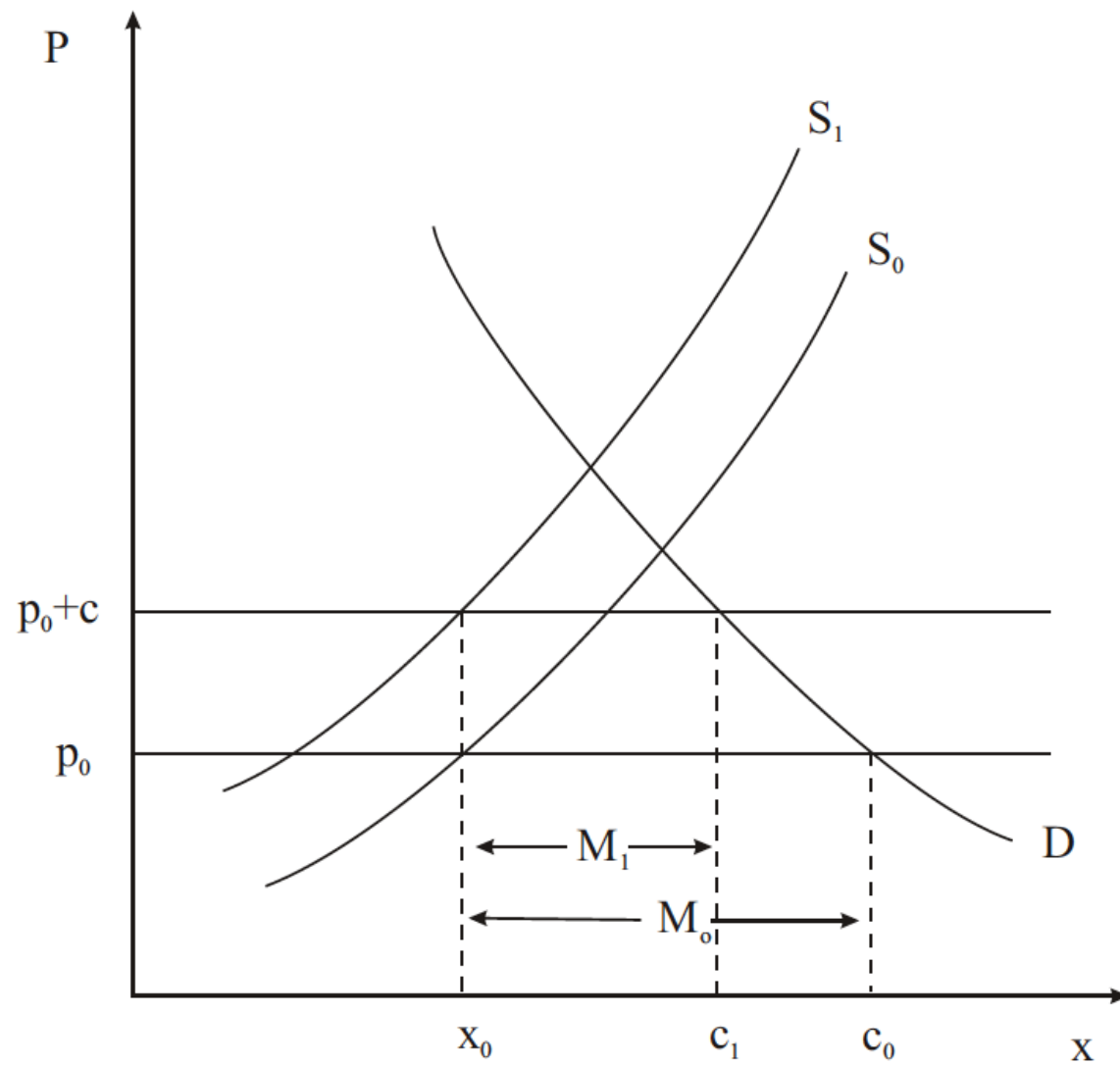
Effect of a product standard on competitiveness.

Early Pollution Haven Model (Copeland and Taylor)

Dornbusch / Fischer / Samuelson continuum trade model
- Two inputs (labour and emissions)
- Supply (or price) one of the inputs (emissions) endogenously determined by benevolent regulator

2 countries (North and South); identical except that North is richer.
- Northern workers are uniformly more productive than Southern workers.

Pollution is generated during production
- Joint output but can equivalently be treated as an input.

Governments set emission taxes τ (in North) and $\tau*$ (in South)

Continuum of goods $i \in [0,1]$ varying in emission intensity

Preferences:

$$U = \int_0^1 b(i) ln[x(i)] di - \beta Z$$

where Z is aggregate domestic pollution

Technology:

Cobb-Douglas with share of emission charges in cost $\alpha(i)$
- $\alpha(i)$ is increasing in i.   High i goods are more polluting.

Governments:

Sets pollution taxes using Samuelson rule (treating world prices as given):

$$\tau = \beta I, \quad \text{where } I \text{ is national income}$$

- Richer county choose more stringent environmental policy

Pattern of trade

If countries are sufficiently different in productivity:

- There is a critical good $\hat{\imath}$ such that all goods cleaner than $\hat{\imath}$ are produced in North and all dirtier than $\hat{\imath}$ are produced in South

If countries sufficiently similar in productivity:

- Factor prices equalize and production of individual goods indeterminate
- Pollution content of trade determined by income
- Richer country is a net exporter of labour services
- Poor country a net exporter of pollution services.

Strengths of model:

- Highlights role of income effects

- Simple, stark pollution haven result allows one to trace through channels via which trade can affect pollution

- Trade and growth have different effects on environment
    - Neutral growth has no effect on pollution
    - Trade increases world pollution via global composition effect

Weaknesses of model:

- Extreme specialization; no trade between Northern countries

- Pollution policy only motive for trade

- Only two types of countries

Generalizations: Intra - industry trade

Apply Romalis (2004)

- M Northern and M Southern countries

- Each industry i produces a variety of differentiated products

- Iceberg transportation costs

Implications

- Pollution policy is a source of comparative advantage

- Less extreme specialization - both Northern and Southern countries produce in both clean and dirty industries

- Motivates tests looking for pollution haven effects using commodity data, emission intensities and policy stringency (Broner et al. 2012)

Generalization: Multiple sources of comparative advantage

Suppose production requires another factor (Capital) in addition to labour and environmental services.

Simple model:

$$x = z^{\alpha} F(K, L)^{1-\alpha}$$

$$y = H(K, L)$$

where H and F have constant returns to scale.

Relative capital abundance interacts with relative stringency of environmental policy in determining pattern of trade.

Conflicting forces determine comparative advantage

Suppose polluting industry is capital intensive and North capital abundant

- North's high income leads to more stringent environmental policy than South → tends to give North a comparative advantage in clean goods

- North's capital abundance tends to give it a comparative advantage in polluting good.

p_x/p_y

RS^S

RS_1^N

RS_0^N

P^S

P_1^N

P_0^N

RD

x/y
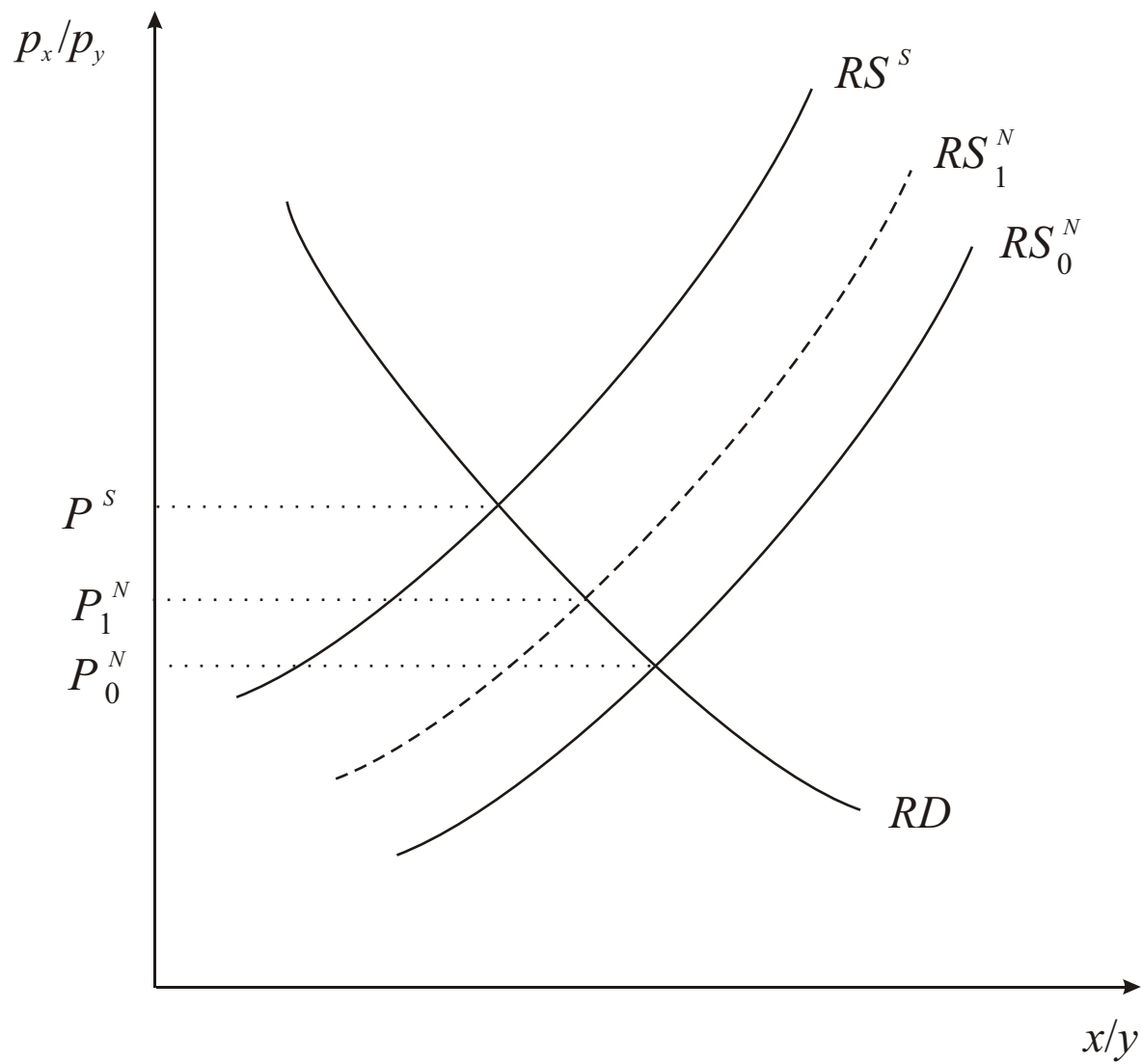
Two sources of comparative advantage

Pollution Haven Hypothesis Fails

If effect of capital abundance stronger than environmental policy, then North has a comparative advantage in clean goods

- Pollution haven hypothesis fails

- Trade liberalization shifts polluting industry to country with more stringent environmental policy

Although pollution haven hypothesis fails, pollution haven effect continues to hold.

Generalization: Home Market Effect

Forslid, Okubo and Sanctuary (2013):

Similar to the Romalis-based extension discussed earlier (intra-industry trade in polluting sectors):

- Constant returns numeraire sector that doesn't pollute

- Two countries identical except in size

Home market effect (HME): Because of transport costs, polluting firms want to locate in the larger market.

Pollution haven effect (PHE): High emission taxes favour production in low tax country

Country with stringent pollution regulation can be net exporter of polluting goods if HME dominates PHE.

Generalizations: Agglomeration

Zeng and Zhao (2009)

- Footloose capital prefers to locate in larger market due to trade costs

- High tax country can export polluting goods if agglomeration effect sufficiently strong.

Pollution Haven Hypothesis (2)

Given the trade regime, to where does pollution-intensive output relocate when one country tightens up environmental policy?

Possibly the key question given that we live in a (relatively) integrated global economy.

Need a model with **multiple countries** to address this question

CGE models looking at carbon leakage consider this issue, but has received relatively little attention in theory literature

Pollution Haven Hypothesis (2)

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With multiple countries, not obvious that polluting production leaving one country will necessarily move to a country with weak environmental policy.

What is the relation between the two versions of Pollution Haven Hypothesis?
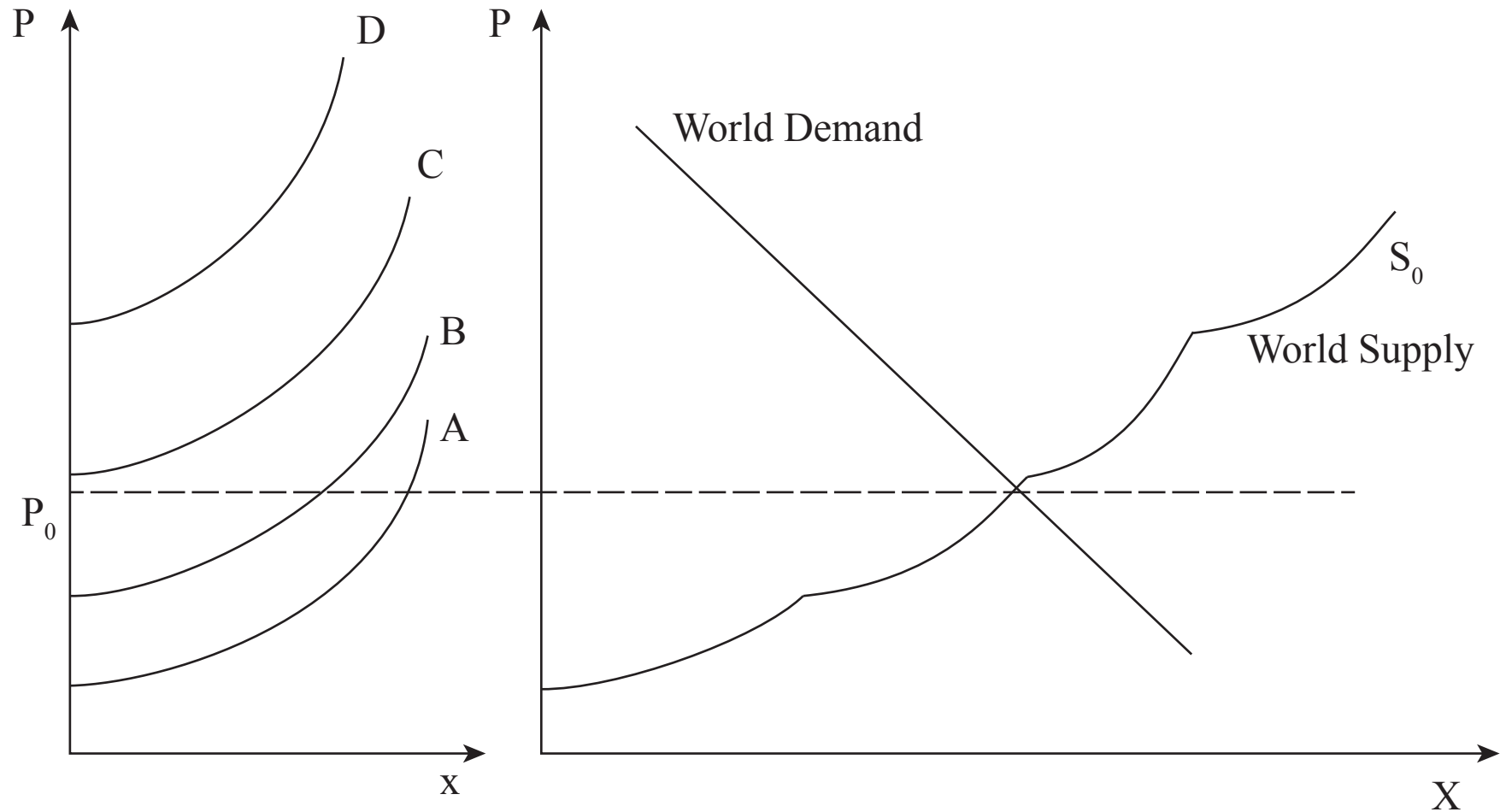
Pollution Haven Hypothesis (2)

Consider a simple partial equilibrium model of a polluting industry (X) with 4 countries.

Suppose

- 2 factors (pollution policy and technology) affect productivity.
- Technology effect dominates environmental policy effect
- Countries with most stringent regulation have highest overall productivity in X
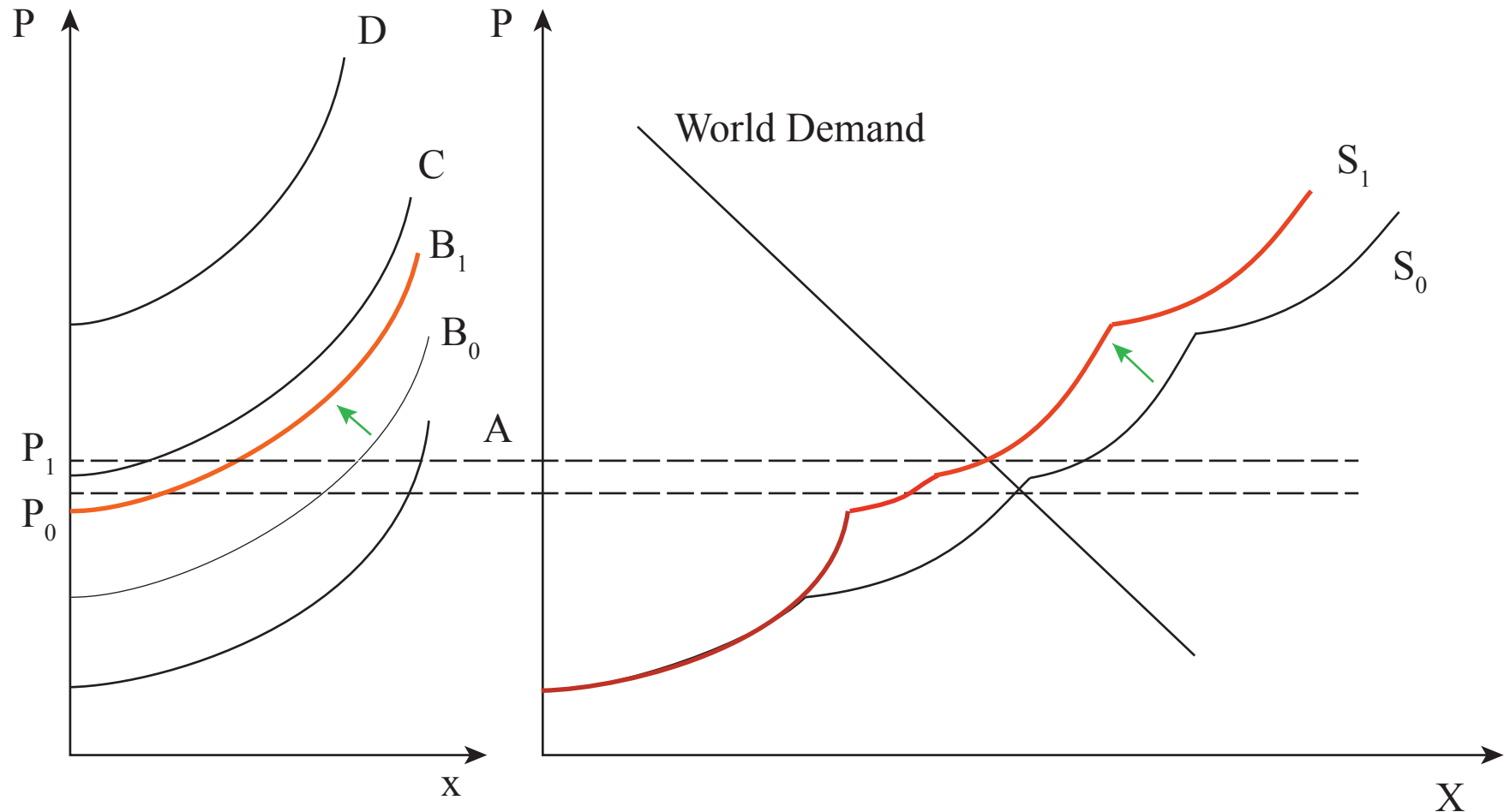
Low cost countries have stringent policy but superior technology

P

D

C

B

A

P_0

x

P

World Demand

S_0

World Supply

X

Pollution Haven Hypothesis fails: trade shifts production to countries with stringent environmental policy

Note trade liberalization raises P in some countries; lowers P in others.

Effect of an increase in emission tax in B

Suppose B tightens up environmental policy

World supply rotates up

Production in B shifts to A (stringent regulation country) and C (weaker regulation country)
  but not to D (country with weakest regulations)

Price rises in all countries so different than effect of trade liberalization

Evidence

Most empirical work has focussed on Pollution Haven <u>Effect</u>

All else equal what is effect of more stringent environmental regulation on some measure of competitiveness (net exports, net inflows of foreign investment, new plant births, etc.)?

Key issues:

- Pollution regulation data
- Unobserved heterogeneity
    - Pollution regulation and net exports driven a third unmeasured factor
- Endogeneity
    - Pollution policy may respond endogenously to net exports

Empirical Evidence: Pollution Haven Effect

US Clean Air Act

- County-level differences in environmental policy
- More stringent environmental policy has significant negative effect on
    - New plant births (Becker and Henderson (2000) and several others)
    - Incoming Foreign Investment (Keller and Levinson, 2002)
- And a positive effect on
    - Relocation of multinational production outside US (Hanna, 2010)

Empirical Evidence: Pollution Haven Effect

US Net Imports (Levinson and Taylor, 2008)

- Pollution abatement costs have a positive and significant effect on net imports from Canada and Mexico in 130 manufacturing industries (1977-1986)

- Once they instrument for pollution abatement costs, the estimates are larger.

- Tighter pollution regulations lower net exports significantly.

- Attribute about 10% of increase in trade volume to increased abatement costs in US

Broner, Bustos and Carvalho:

Sources of Comparative Advantage in Polluting Industries

(NBER 2012)

Explain exports to US from 70+ countries in 80 industries in one year using an approach used by Romalis adapted to allow for pollution

$$M_{ic} = \beta_1 \ E_c \times e_i + \beta_2 \ K_c \times k_i + \beta_3 \ H_c \times h_i + \alpha_c + \alpha_i + \varepsilon_{ic},$$

- M_{ic} is country c's import share in sector i in US divided by average share of country c in US imports
- K_c and H_C are country c's capital and human capital endowments
- k_i and h_i are capital and human capital intensities in industry i
- E_c is a measure of laxity of pollution regulation in country c
- e_i is US emission intensity in sector i

Broner, Bustos and Carvalho, cont.

- One of a very few studies to use variation across countries in environmental policy (lead content of gasoline)

- Find that coefficient of environmental term is positive and significant in OLS and larger when instrument for environmental policy

- Environmental variable has an impact on par with other factor endowment measures

Empirical Evidence: Pollution Haven Hypothesis (1)

Not much evidence

Antweiler, Copeland and Taylor (2001) try to isolate pure effect of openness on SO2 concentrations in cities.

- Openness tends to raise SO2 in richer countries and lower it in poorer countries

- Consistent with capital abundance and other factors affecting trade more strongly than environmental policy (see also work by Cole and Elliott on this)

- But focus is on ambient pollution outcomes rather than trade directly

Empirical Evidence: Pollution Haven Hypothesis (1)

Ederington, Levinson, and Minier (2004):

- Pollution content of US imports from non-OECD countries falls over time (1972 - 94) , but pollution content of US exports stays about the same. Opposite to what pollution haven hypothesis predicts

- Econometric test of the pollution haven hypothesis: imports in polluting industries in US are less sensitive to tariff reductions than other industries. Interpret this as evidence against pollution haven hypothesis

Empirical Evidence: Pollution Haven Hypothesis (2)

Extensive CGE literature on Carbon leakage, but relatively little econometric evidence

Some papers look at whether outbound FDI to developing countries is affected by abatement costs in source country

These studies lack data on environmental policy in host countries

Empirical Evidence: Pollution Haven Hypothesis (2)

Eskeland and Harrison (2003):
- Little evidence that US abatement costs influence outbound FDI to developing countries

Elliot and Shimamoto (2008):
- No evidence that higher Japanese abatement costs increased outbound investment to Malaysia, Indonesia and the Philippines

Cole and Elliott (2005):
- Some evidence that industries with high US abatement costs were have high outbound investment to Brazil and Mexico
- Chose Brazil and Mexico because relatively capital abundant

Empirical Evidence: Pollution Haven Hypothesis (2)

Feddersen (2013)

- Finds evidence that more stringent environmental policy in neighbouring countries has a positive effect on domestic value added.

Aichele and Felbermayr (2013)

- Use a gravity model to study effects of Kyoto protocol commitments on carbon content of bilateral trade.

- Find that embodied carbon imports from committed to non-committed countries rose by 8%

Conclusion

- Growing body of evidence suggests that stringency of environmental policy affects competitiveness (support for pollution haven effect)

- Little evidence in support of pollution haven hypothesis (1). Other factors, such as productivity and labour costs, are more important determinants of trade and investment patterns than environmental policy.

- Pollution haven hypothesis (2) may be the most relevant given the existing trade regime
  - Little theoretical work so far; need multi-country models
  - Likely more potential for empirical work than pollution haven hypothesis (1)