Pollution Haven Models of International Trade
Pollution Havens

• Poor countries “forced” to produce the dirty goods for the rich countries
• Rich countries avoid dirty production by importing dirty goods from poor countries

• Mechanism:
  – trade pattern
  – differences in production costs
  – differences in environmental regulation
  – differences in income
Modelling

• Two region model: North versus South (*)
• Each region: many small identical countries
• North imports dirty good (m > 0)
• South exports dirty good (m* < 0)
• Use results of previous chapter to see what happens if N and S open up to trade.
• To be sorted out:
  – Comparative advantage: *why* does N import?
  – Does trade raise *world* pollution level?
Comparative Advantage

• Suppose $\tau > \tau^*$, but preferences, technology and endowments the same in N and S

• We now show that North will import

• Relative demand $\frac{x^c}{y^c} = \frac{b(p)I}{[1-b(p)]I} = RD(p)$

• Relative supply $\frac{x}{y} = \frac{L \cdot x(p,e,K/L)}{L \cdot y(p,e,K/L)} = RS(p,e,K/L)$

• Market clearing:

$$\frac{x + x^*}{y + y^*} = \frac{x^c + x^c^*}{y^c + y^c^*} \implies s_y \frac{x}{y} + s_y^* \frac{x^*}{y^*} = \frac{x^c}{y^c}$$
A BY
L
X L
Y
Z
X
Consumer prices
slope=-p
Net frontier
slope=-p(1-a )
Gross frontier
slope=-1

Z^A = \alpha b / \gamma

Z = ex
Goods Market Equilibrium

• Insert Figure 5.2

• Autarky: \[ RS(p^A, e, K/L) = RD(p^A) \]
  \[ RS(p^{A*}, e^*, K^*/L^*) = RD(p^{A*}) \]

• Free Trade:
  \[ s_yRS(p^T, e, K/L) + s^*_yRS(p^T, e^*, K^*/L^*) = RD(p^T) \]

• The diagram is central to this chapter:
  – 5.2: \( \tau > \tau^* \) (exog) -- diagram -- North imports
  – 5.3: \( z < z^* \) (exog) -- \( \tau > \tau^* \) -- diagram -- N imports
  – 5.4: \( K > K^* \) -- \( \tau > \tau^* \) -- diagram -- N imports
Efficient Policy

• Assume $K/L = K^*/L^*$ but $K = \lambda K^* > K^*$

• Policy rule:

$$\tau = MD(p, \frac{G(p, \lambda K, \lambda L, z)}{\beta(p)}, z) = G_z(p, \lambda K, \lambda L, z)$$

• $\lambda = 1$ gives policy in South

• $\lambda > 1$ gives policy in North

• $MD$ and $G_z$ shift up if $\lambda$ rises, so $\tau > \tau^*$

• So again, North imports $X$ (RS/RD diagram)
World Pollution Level

• Trade -- z falls, but z* rises -- world z?
• Special case that allows exact results
  – Cobb Douglas demand: \( px^c / I = b \) constant
  – linear disutility of z
  – CRRA “blue welfare”
  – usual production structure \( \tau z/px = \alpha \)
  – define (book: \( \theta \)) \( px/G = s_x \)
  – define \( G/(G + G^*) = \phi \)

• Efficient policy:
  \[ z = (\alpha / \gamma) s_x R^{1-\sigma} \]

• World market clearing:
  \[ s_x \phi + s_x^* (1 - \phi) = b \]
  • only with free trade of course
World Pollution Level

• Efficient Policy: \[ z = \left( \frac{\alpha}{\gamma} \right) s_x R^{1-\sigma} \]

\[ z^* = \left( \frac{\alpha}{\gamma} \right) s_x^* R^{*1-\sigma} \]

• Trade Liberalisation:
  – \( R^{1-\sigma} \) changes (scale + technique effect)
  – \( s_x \) changes (world composition effect)
  – Decompose change in world pollution when opening up to trade
Asymmetric Policy

• Suppose North regulates but South does not
• North and South are the same in all other respects
• Distinguish
  – marginal policy reform:
    • start from no intervention and free trade
    • introduce small tax in North
  – discrete policy reform:
    • start from efficient tax in North, no tax in South, no trade
    • open up to free trade
Marginal Policy Reform

• Start from: no intervention and free trade
• So: \( e = e^* = 1 \)
• Note: \( m = m^* = 0 \)
• North reduces (marginally) \( z \)
  – so \( dz > 0 \), \( dz^* < 0 \)
• Marginal welfare change:

\[
\frac{dV}{V_I} = \underbrace{-m \cdot dp}_{\text{gains from trade}} + \left[ \tau - MD(p, R, z) \right] \cdot dz
\]

• North gains, South loses
Jump to Free Trade

• Assume North always sets efficient environmental policy
• South: no environmental policy
• Compare “no trade” to “free trade”
• We will show that South might gain, even if North and South identical otherwise
  – of course South gains if it has no harm from pollution
  – note: just one (specific) example suffices
• Intuition: gains from trade outweigh loss from increased pollution
A Ricardian Model

• Assumptions:
  
  – Labour only (Ricardian): \( x = z^\alpha L_x^{1-\alpha} = e^{\alpha/(1-\alpha)} L_x \)
  
  \[ y = L - L_x \]
  
  – Cobb Douglas Demand: \( \frac{px^c}{y^c} = \frac{b}{1-b} \)
  
  \[ \beta(p) = \left( \frac{p}{b} \right)^b \left( \frac{1}{1-b} \right)^{1-b} = p^b / B \]
  
  – Logarithmic utility: \( V = \ln G - \ln(p^b / B) - \gamma z \)
  
  \[ \frac{1}{G} Gz - \gamma = 0 \quad \Rightarrow \quad \tau = \gamma G \]
  
  – Book imposes symmetry: \( L = L^* \)
Autarky in South

• $e^* = 1$ so $x^* = L_x^* = z^*$

• Firms: $p_y^* \cdot \frac{\partial y^*}{\partial L_y} = p_x^* \cdot \frac{\partial x^*}{\partial L_x} = w^*$

  $\iff 1 = p^* = w^*$

  $\implies G^* = L^*$

  $z^* = x^* = bL^*$

  $V^* = \ln L^* - \ln B - \gamma bL^*$
Autarky in South

\[ Y = \frac{1-b}{b} X \]

(1-b)L

\( z = x \)

\( bL \)
Autarky in North

• Efficient Policy: \( \tau = \gamma G \)
  - profit maximization \( \tau z = \alpha px \)
  - consumer demand \( px = bG \)

• Firms: \( p_y \cdot \frac{\partial y}{\partial L_y} = p_x \cdot \frac{\partial x}{\partial L_x} = w \)

\[ \Leftrightarrow 1 = p(1 - \alpha)z^\alpha L^{-\alpha}_x = w^* \]

\[ L_x = [p(1 - \alpha)]^{1/\alpha} \frac{\alpha b}{\gamma} \]

• Use production function and demand to solve for \( p: \)

\[ p = \left( \frac{\gamma L}{\alpha(1 - \alpha b)(1 - \alpha)^{(1-\alpha)/\alpha}} \right)^\alpha > 1 \]
Autarky in North

\[ Y = \frac{1 - b}{b} Xp \]

Comparing North to South amounts to increase in tax

\[ Y = \frac{1 - b}{b} X \]

\[ z = ex \]

\[ z = x \]
Free Trade

- We expect: \( p^{Aut^*} = 1 \leq p^T \leq p^{Aut} \)
- Impossible that both goods are produced in both regions: at least one country fully specializes

\[ \frac{\partial y}{\partial L_y} \leq w, \quad p \cdot \left( \frac{\partial x}{\partial L_x} \right) \leq w \]

Inequality if zero production

- if \( p > 1, \ y^* = 0 \)
- if both regions produce \( y \): \( w = w^* = 1 \), but then cost \( x \) in North is higher than in South, so \( x = 0 \)
South Produces Only X

• Assume $p > 1$ (check later) so $y^* = 0$
• Assume $x > 0$ (check later, requires large $b$)
• Focus on welfare in South: higher than in autarky?
• Production: $y^* = 0$, $x^* = L^* = z^*$, $G^* = pL^*$
• Consumption: use trade balance

\[ (1 - b) pL^* = p(L^* - x^c) \implies x^c = bL^* \]
Free Trade Equilibrium South

\[ Y = \frac{1-b}{b} X \]

Graph showing the equilibrium point with axes labeled as \( X \) and \( Y \), and \( p^T \) representing the price vector. The line \( Y = \frac{1-b}{b} X \) intersects the axes at points labeled \( (1-b)L \) and \( bL \), with a blue star indicating the equilibrium point on the graph.

The equation \( z = x \) is also shown, indicating the equality between output and input.
Welfare Comparison

\[ V^* = \ln G^* - b \ln p + \ln B - \gamma z^* \]

\[ u^{T*} = (\ln L^* + \ln p^T) - b \ln p^T + \ln B - \gamma L^* \]

\[ u^{A*} = (\ln L^* + \ln 1) - b \ln 1 + \ln B - \gamma b L^* \]

\[ u^{T*} - u^{A*} = (1 - b)(\ln p^T - \gamma L^*) \]

• South gains from trade if \( \ln p^T > \gamma L^* \)

• So we need to solve for equilibrium world price, which takes a while...
World Price

- Implicit function:

\[ p^{1/\alpha} \left[ \frac{1-\alpha}{\alpha} \frac{(1-\alpha)}{\gamma L} (1-\alpha b) \right] + p \left[ (1-b)\alpha + \frac{1-b}{b} \left( \frac{L^*}{L} - 1 \right) \right] = 1 \]

- If \( p = p^A \), LHS > 1
- LHS increases in \( p \)
- Unique equilibrium
What Makes South Gain

\[ p^{1/\alpha} \left[ (1 - \alpha) \frac{1-\alpha}{\alpha} \frac{\alpha}{\gamma L} (1 - \alpha b) \right] + p \left[ (1 - b)\alpha + \frac{1-b}{b} \left( \frac{L^*}{L} - 1 \right) \right] = 1 \]

- if \( L = L^* \), LHS decreases in \( b \)
  - so high \( b \) means high \( p \)
  - South gains more from specialising in \( X \) if demand for \( X \) is higher

- LHS increases \( L^*/L \)
  - so small \( L^*/L \) means high \( p \)
  - South gains more if it gets access to a large trading area