Trade, Leakage, and the Design of a Carbon Tax

Environmental and Energy Policy and the Economy Conference

19 May 2022
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Policy Goal
Policy Goal

• Reduce *global* carbon emissions

• at minimum economic cost
Challenge
Challenge

• Globally harmonized carbon price is a dream
  • a country or coalition will need to act on its own
Question
Question

• What are principles of design for a carbon tax?
  • in this world of trade and potential carbon leakage
Principle I
Principle I

• Tax both supply and demand for fossil fuels
  • more tax on supply if foreign extraction is inelastic
    (idea implicit in analysis by James Markusen, 1975)
Principle I in Practice
Principle I in Practice

• Impose nominal tax on fossil-fuel extraction
  • add partial border adjustments on fuel imports & exports
Principle I in Practice

- Impose nominal tax on fossil-fuel extraction
  - add *partial border adjustments* on fuel imports & exports
- Partial BAs are at *lower rate* than nominal tax
  - even lower if foreign supply is inelastic
  - *current proposals* have full BAs; hence supply untaxed
Principle II
Principle II

• Tax carbon in goods production and consumption
  • tax imports at same rate as domestic consumption
  • tax exports at a lower rate, dictated by leakage rate
Principle II in Practice
Principle II in Practice

- Impose nominal tax on fossil-fuel extraction
  - partial border adjustments on fuels (Principle I)
Principle II in Practice

• Impose nominal tax on fossil-fuel extraction
  • partial border adjustments on fuels (Principle I)

• Add BAs on carbon in goods
  • impose on imports at same rate as for fuels
  • rebate on exports at lower rate, in proportion to leakage
Principle III
Principle III

• If foreign supply elasticity and leakage rate are low
  • tax only extraction and production
  • minimizes administrative costs
Principle III in Practice
Principle III in Practice

• Impose nominal tax on fossil-fuel extraction
  • partial border adjustments on fuels (Principle I)
  • low foreign extraction elasticity -> tax mostly supply
  • low leakage -> leave tax on goods exports (Principle II)
Principle III in Practice

• Impose nominal tax on fossil-fuel extraction
  • partial border adjustments on fuels (Principle I)
  • low foreign extraction elasticity -> tax mostly supply
  • low leakage -> leave tax on goods exports (Principle II)

• No BAs on goods, so no sweat!
  • maintain partial BAs on fuels, but that’s easy
Economic Rationale
Economic Rationale

• Remainder of the presentation
  • justify and illustrate these three principles
Principle I

• Tax both supply and demand for fossil fuels
  • more tax on supply if foreign extraction is inelastic
Closed-Economy Equilibrium

Energy Supply

Energy Demand

Home

$p_e + t_c$

$p_0$

$p_e$

$t_c$

$Q_e = C_e$
Trade Equilibrium: Consumption Tax

Weisbach, Kortum, Wang, and Yao

Common price of energy

Exports

$C_e \quad Q_e \quad Q_e^* \quad C_e^*$
Trade Equilibrium: Extraction Tax

\[ p_e - t_e \]

\[ p_e \]

Common price of energy

Imports

\[ Q_e \]

\[ C_e \]

\[ C_e^* \]

\[ Q_e^* \]
Optimal Policy: Equations
Optimal Policy: Equations

\[
\frac{t_e}{t_c} = \frac{|C_e'|}{Q_e''}
\]
Optimal Policy: Equations

\[
\frac{t_e}{t_c} = \frac{|C_e'|}{Q_e'^*}
\]

\[
t_e + t_c = \varphi^W
\]
Inelastic demand

With inelastic demand, Home relies on a consumption tax.

\[ C_e^*(p_e) \]

\[ Q_e^*(p_e) \]

\[ p_e + t_c \]

\[ p_e \]

\[ p_e - t_e \]
• Foreign taxes

\[ t_e^* + t_c^* = \mu^* \]
• Foreign taxes

\[ t_e^* + t_c^* = \mu^* \]

• Optimal policy

\[ t_e = t_e^* + (\varphi^W - \mu^*) \frac{|C_e'|}{Q_e' + |C_e'|} \]

\[ t_c = t_c^* + (\varphi^W - \mu^*) \frac{Q_e'}{Q_e' + |C_e'|} \]
Principle II

• Tax carbon in goods production and consumption
  • tax imports at same rate as domestic consumption
  • tax exports at a lower rate, dictated by leakage rate
## Carbon Flows: OECD and Foreign

<table>
<thead>
<tr>
<th></th>
<th>Home</th>
<th>Foreign</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Home</strong></td>
<td>$C^d_e = 11.3$</td>
<td>$C^m_e = 2.5$</td>
<td>$C_e = 13.8$</td>
</tr>
<tr>
<td><strong>Foreign</strong></td>
<td>$C^x_e = 0.9$</td>
<td>$C^f_e = 17.6$</td>
<td>$C^*_e = 18.5$</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$G_e = 12.2$</td>
<td>$G^*_e = 20.1$</td>
<td>$C^W_e = 32.3$</td>
</tr>
<tr>
<td><strong>Extraction</strong></td>
<td>$Q_e = 8.6$</td>
<td>$Q^*_e = 23.7$</td>
<td>$Q^W_e = 32.3$</td>
</tr>
</tbody>
</table>

Units: gigatons of CO$_2$. The production tax considered in Section 3.3 restricts $t_d = t_x = 0$ and $t_m = 0$. The combination of all three taxes considered in Section 3.4 removes these restrictions, allowing arbitrary combinations of production and consumption taxes. Note that these taxes are effective taxes. While effective taxes are unique, there are a number of different ways to implement them. In particular, instead of directly imposing the effective taxes, Home could start with a nominal extraction tax and impose border adjustments on imports and exports of energy and of goods. Various combinations of border adjustments produce each of the policies we consider. We defer the discussion of implementation to Section 3.5, and here work with effective taxes.

Because we are working with prices and taxes, it is convenient to use indirect utility functions, which give the maximum welfare that a region can attain given spending and prices. We interpret those prices as being the effective prices of the energy embodied in the goods that are consumed. Under a consumption tax that price is $p_e + t_c$ for goods consumed in Home and $p_e$ for goods consumed in Foreign, no matter where they are produced. Under a production tax it is $p_e + t_p$ for goods produced in Home and $p_e$ for goods produced in Foreign, no matter where they are consumed. Production and trade in services means wages (and the price of services) are 1 in both regions.
Taxing the Demand Side

• Three places to tax demand
  
  • want to equalize tax on Home consumption
  
  • expands tax base and doesn’t distort consumption

\[ C^d_e, C^m_e, C^x_e \]

\[ t_d = t_m = t_c \]
Taxing Exports

- Want to tax exports, but beware of leakage!
  - optimal tax rate is \( t_x = (1 - \Lambda^*)t_c \)
  - leakage rate

\[
\Lambda^* = - \frac{\partial C^f_e/\partial t_x}{\partial C^x_e/\partial t_x} > 0
\]
Principle III

- If foreign supply elasticity and leakage rate are low
  - tax only extraction and production
  - minimizes administrative costs
Simulating the Model
Simulating the Model

• Examine the performance of different policies
  • focus on combination of extraction and production tax
OECD: Low Foreign Supply Elasticity

Figure 5: Policy Frontiers of OECD with Low Foreign Elasticity

Figure 6: Policy Frontiers of OECD with High Foreign Elasticity
OECD: High Foreign Supply Elasticity

Figure 5: Policy Frontiers of OECD with Low Foreign Elasticity

Figure 6: Policy Frontiers of OECD with High Foreign Elasticity
OECD and China: High Foreign Supply Elasticity

Figure 7: Policy Frontiers of OECD plus China with Low Foreign Elasticity

Figure 8: Policy Frontiers of OECD plus China with High Foreign Elasticity
Conclusions

• Ideas for tweaking current carbon tax proposals
  • to make them more effective or easier to administer

• Reduce BAs on fuels to leave a tax on supply
  • reduce BAs on goods exports to keep them in tax base

• Consider a simple extraction-production tax
  • partial BAs on fuels and no BAs on goods