‘Principles for Pareto efficient border carbon adjustment’

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Introduction

- Border Carbon Adjustment Mechanisms (BCAMs): 'Schemes that levy a charge on the carbon content embodied in imports that the importing country regards as in some sense underpriced or otherwise excessive'
- After many years of heated debate BCAMs are becoming reality
  - EU has begun the transition to full adoption of a BCAM in 2030 (European Parliament and Council of the European Union (2023))
  - UK is committed to adopt a BCAM in 2027 (Government of the UK (2023))
  - Canada is in reflection stage after a public consultation (Government of Canada (2021))
  - In the U.S., some form of BCAM is a recurrent feature of legislative proposals for climate action (Gangotra and Kennedy (2023) and Bistline et al. (2024))
- Use and design of BCAMs remains highly contentious and politically charged!

Carbon pricing and/or regulation? And form of BCAM

- Common presumption in the formal analysis of BCAMs (Keen and Kotsogiannis (2014)) that mitigation (the reduction of emissions) is by carbon pricing
- But many countries mitigate using a wide range of other mitigation instruments
  - Such as performance standards, subsidies and tax credits for investment in, or energy sourced by, renewables (U.S and the Inflation Reduction Act of 2022 is leading example)

Policy relevance

- In the EU and UK schemes other mitigation measures should not be part of the BCAM (the charge due on imports will be reduced only to reflect explicit carbon prices paid abroad, so entirely ignoring any other form of mitigation)
- In the US (Infaction Reduction Act of 2022) and in Canada other mitigation measures should be part of the BCAM
- But whatever the structure, BCAMs are a reality, so understanding structure is important

Questions

Two important, and policy relevant, questions arise:

1. Should allowance be made in calculating the BCAM for mitigation measures abroad other than explicit carbon pricing?
2. What is the optimal BCAM if the BCA-imposing countries are not completely free in their mitigation policy and so set it at efficient levels?

Preview of results: General principles

1. Regulation should be treated the same as carbon
2. Constrained Pareto efficiency requires a generalized form of BCAM which looks not to the difference between domestic and foreign (explicit or shadow) carbon prices, but to the difference in how far each deviates from the first best level: a 'difference-in-differences' BCAM
3. 2nd general principle nests, as special cases, the EU and U.S approach to BCAM

Overview of the model

- Simplified version of Keen and Kotsogiannis (2014)
- Competitive global economy with just two goods and two countries
- One good is clean (and numeraire) and other good is “dirty”
- “Dirty” whose production generates harmful emissions, affecting consumer
- Emissions are global (transboundary)
- “Foreign” (and “home”) country’s carbon pricing is inefficient
- “Home” country deploys of some form of BCAM (and the “foreign” is passive)
- Within this objective is to characterise BCAM: Structure of tariff on imports of dirty (accounting for distributional concerns too)

Elements of the model: Preferences (home)

- Expenditure function of the form

$$e(p_n, p, u) + p_n \, \theta \, k \tag{1}$$

where

  - p_n is price of numeraire
  - $p = w + t$ the (consumer and producer) price of the dirty good
  - u indicates home welfare
  - $\theta > 0$ the damage they cause to the home country
  - k global emissions

Elements of the model: Production (home)

- Production decisions are described by a revenue function

$$r(p, s) \equiv \max_{x_n, x, z}\{x_n + p\,x - s\,z :\ (x_n, x, z) \in f\} \tag{2}$$

- $r(p, s)$ is convex with
  - $r_p = x$ and $r_s = -z$
- Mitigation through carbon pricing or regulatory measures
  - Define shadow price $\bar{z} = -r_s(p, \bar{s})$ and so
    - $x = r_p(p, s^*)$
    - $z = -r_s(p, s^*)$ where $s^* = \max\{s, \bar{s}\}$
- Adjusted revenue function then is

$$g(p, s, s^*) = r(p, s^*) - (s^* - s)r_s(p, s^*) \tag{3}$$

Elements of the model: Global emissions

$$\begin{aligned} k\left(p, P, s^*, S^*\right) &= z + Z \\ &= -r_s\left(p, s^*\right) - R_S\left(P, S^*\right) \end{aligned} \tag{4}$$

Elements of the model: Market clearing and income

$$m\left(p, s^{*}, u\right) + M\left(P, S^{*}, U\right) = 0 \tag{5}$$

$$e(p, u) + \theta k = g(p, s^{*}, s) - s r_{s}(p, s^{*}) + t m\left(p, s^{*}, u\right) - \alpha \tag{6}$$

Constrained Pareto efficiency

$$
\begin{aligned}
\max_{w,u,U,s} \mathcal{L} &= u + \phi(U - \bar{U}) \\
&+ \lambda\{e(p,u) + \theta k(\cdot) - g(\cdot) + sr_s(p,s^*) - tm(p,s^*,u) + \alpha\} \\
&+ \Lambda\{E(P,U) + \Theta k(\cdot) - G(\cdot) + SR_S(P,S^*) - TM(P,S^*,U) - \alpha\} \\
&+ \mu\{m(p,s^*,u) + M(P,S^*,U)\} \qquad (7)
\end{aligned}
$$

Results

BCA with transfers

Whatever its domestic mitigation policy s^*, and given $T = 0$, when international transfers are freely available, constrained Pareto efficiency requires a tariff in the home country of

$$t = (s^* - \theta^A) \underbrace{\left(\frac{r_{sp}(p, s^*)}{m_p(p, s^*, u)} \right)}_{(+)\ weight} - (S^* - \theta^A) \underbrace{\left(\frac{R_{SP}(P, s^*)}{M_P(P, s^*, U)} \right)}_{(+)\ weight} \tag{8}$$

where $\theta^A = \theta + \Theta$

Interpretation

Two different interpretations:

Interpretation 1 (gain and losses)

A more precise intuition follows on noting that the 'diff-in-diff' BCAM implies that...

$$\underbrace{-t\frac{dm}{dt}}_{\text{marginal welfare loss}} = \underbrace{(\theta^A - S^*)\left(-\frac{dZ}{dt}\right)}_{\text{marginal gain from less } Z} - \underbrace{(\theta^A - s^*)\frac{dz}{dt}}_{\text{marginal loss from } z}, \quad (9)$$

Interpretation 2 (elasticities)

And in elasticities...

$$\frac{r_{sp}(p, s^*)}{m_p(p, s^*, u)} = \left(\frac{z}{x}\right)\frac{\epsilon(z, p)}{\epsilon(e_p, p)\left(\frac{e_p}{x}\right) + \epsilon(x, p)} \quad (10)$$

where $\theta^A = \theta + \Theta$

Fixed coefficients

Proposition 2: Fixed coefficients

Under the conditions of Proposition 1, suppose further that, in both countries, emissions intensities are technological constants and that compensated demands are perfectly inelastic. Then:

(a) If technologies in each country are the same, constrained Pareto efficiency requires a tariff in the home country of

$$t = (s^* - S^*)B \tag{11}$$

(b) If binding prices in each country are the same, at say s', constrained Pareto efficiency requires a tariff in the home country of

$$t = \tilde{s}(B - b) \tag{12}$$

where $\tilde{s} \equiv \theta^A - s'$

Unconstrained mitigation policy

Proposition 3: Unconstrained mitigation policy

Under the conditions of Proposition 1, if mitigation in the home country is efficient—whether achieved by price or regulation—then $s^* = \theta^A$, and constrained efficiency requires a tariff in the home country of

$$t = \underbrace{(s^* - S^*)}_{dif.\ in\ carbon\ pricing\ in\ home\ and\ foreign} \underbrace{\left(\frac{R_{SP}(P, S^*)}{M_P(P, S^*, U)}\right)}_{behaviouralresponses} \qquad (13)$$

When revenue matters

Proposition 4: BCA when revenue matters

Under the conditions of Proposition 1, but now valuing home revenue from the tariff and any carbon tax by the marginal value of public funds $1 + v$, constrained Pareto efficiency requires—whatever the mitigation policy is there—that the home tariff be

$$t = \frac{1}{(1+v)}\left\{ \left(s^* + vs - \theta^A\right)\left(\frac{r_{sp}}{m_p}\right) - \left(S^* - \theta^A\right)\left(\frac{R_{SP}}{M_P}\right)\right\} + \frac{v}{1+v}\left(\epsilon(m,p)\frac{dlnp}{dt}\right)^{-1}. \quad (14)$$

Cross-country distributional concerns

Proposition 5: With cross-country distributional concerns

Whatever its domestic mitigation policy s^*, constrained Pareto efficiency requires a tariff in the home country of

$$t = \sigma T - (\sigma - 1)\left(\frac{M}{M_P}\right) + \underbrace{(s^* - \theta^{AA})\left(\frac{r_{sp}}{m_p}\right) - (\sigma S^* - \theta^{AA})\left(\frac{R_{SP}}{M_P}\right)}_{BCA\ term} \quad (15)$$

where $\theta^{AA} \equiv \theta + \sigma\Theta$.

- Aggregate damage is weighted by σ
- If $\sigma > 1$ (foreign low income) then Pareto efficiency requires home subsidy to transfer resources

Self-interest

Proposition 6: BCA with self-interest

If wholly self-interested, the unconstrained country, whatever its domestic mitigation policy—and assuming there to be fixed emissions intensities in both countries—will set a tariff of

$$t = M(M_P)^{-1} + \theta B - (\theta - s^*)b \tag{16}$$

- $M(M_P)^{-1}$ terms of trade
- θB impact of foreign on home
- $(\theta - s^*)b$ impact of underpricing at home

Concluding Remarks

- The adoption of BCAMs opens a new frontier in efforts to use of tax-like tools to address climate change—efforts that so far have been, to put it mildly, disappointing
- Understanding how they are to be best designed is thus of some importance
- In that spirit, the results here suggest two principles for the desirability and structure of Pareto efficient BCAMs
- The first is that efficiency arguments for a BCAM and results on its appropriate structure apply with perfect symmetry to explicit carbon prices and shadow prices associated with mitigating regulatory measures
- The second principle is that a generalized 'difference-in-differences' form of BCAM is required for Pareto efficiency

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