Measures to Enhance the Effectiveness of International Climate Agreements: The Case of Border Carbon Adjustments

Alaa Al Khourdajie, & Michael Finus

University of Bath, UK

Border Carbon Adjustments

- non-excludability of public good provision
- leakage effects
- import tariffs (emission tax)
- output-based rebates (OBRs)
- tariff plus OBRs = consumption-based environmental tax
- OBRs: violation of strong-polluters pay principle

Related Literature (1)

Issue 1: Design and Practicability of BCAs

compatibility with WTO-rules

Issue 2: Economic Justification of Trade Measures

standard trade theory: “law of comparative advantages”

correction of market-imperfections (global pollutant)

Related Literature (2)

Issue 3: Effectiveness of Trade Measures

a) Simulations (CGE)

OBRs address leakage but do not reduce greenhouse gases noticeably, this requires tariffs

policy levels exogenous; no agreement formation

b) Theory

strategic trade models of imperfect competition

no agreement formation, or only stability of grand coalition

b) Theory

game-theoretic analysis of agreement formation

- positive and normative properties of agreement formation
- effect of different institutional rules/designs on outcomes

strategic trade & environ.: Barrett 1994, Conrad 1993, Kennedy 1994, Ulph 1996 … (no agreement formation)

international environmental agreements (IEAs): Barrett 1994, Carraro/Siniscalco 1993 … (no trade)

strategic trade, taste for variety, plus coalitions: Yi 1996 and 2000 (no environment)

Model

- ***Stage 1: Choice of Membership, Countries***

  coalition $S \subseteq N$, all non-signatories are singletons, simultaneous, open membership

- ***Stage 2: Choice of Policy Level, Countries***
  - choice of taxes, signatories cooperatively, non-signatories non-cooperatively
  - No-BCA-Regime
  - BCA-Regime

- ***Stage 3: Choice of Output Levels, Firms***
  - decision how much to produce and for which market

Model

$$W_i = CS_i + PS_i - D_i + TR_i + BCR_i$$

$$W_j = CS_j + PS_j - D_j + TR_j$$

$$u_i(q_i; M_i) = v_i(q_i) + M_i = aQ_{i.} - \frac{\gamma}{2}Q_{i.}^2 - \frac{1-\gamma}{2}\sum_{k\in N} q_{ik}^2 + M_i$$

$$p_{ik} = \frac{\partial u_i}{\partial q_{ik}} \Longleftrightarrow p_{ik} = a - (1-\gamma)q_{ik} - \gamma Q_{i.} \Longleftrightarrow p_{ik} = a - q_{ik} - \gamma \sum_{l\in N, l\neq k} q_{il}$$

$$CS_i = aQ_{i.} - \frac{\gamma}{2}Q_{i.}^2 - \frac{1-\gamma}{2}\sum_{k\in N} q_{ik}^2 - \sum_{k\in N} q_{ik}p_{ik}$$

Model

$$PS_i = \sum_{k \in S} \pi_{ki} + \sum_{l \in N \setminus S} \pi_{li} = \sum_{k \in S} q_{ki}(p_{ki} - c - t_i) + \sum_{l \in N \setminus S} q_{li}(p_{li} - c - t_i)$$

$$PS_j = \sum_{k \in S} \pi_{kj} + \sum_{l \in N \setminus S} \pi_{lj} = \sum_{k \in S} q_{kj}(p_{kj} - c - t_j - \Omega) + \sum_{l \in N \setminus S} q_{lj}(p_{lj} - c - t_j)$$

$$with \;\; \Omega = \begin{cases} \phi(t_i - t_j) & if \;\; t_i > t_j \\ 0 & if \;\; t_i \leq t_j \end{cases}$$

Model

$$TR_i = t_i \sum_{k \in N} q_{ki}$$

$$BCR_i = \Omega \sum_{j \in N \setminus S} q_{ij}$$

$$TR_j = t_j \sum_{k \in N} q_{kj}$$

$$D_l = \delta Q$$

Driving Forces I

- Generally: quantities decrease in own and increase in foreign taxes.
- Exception 1: $\gamma = 0$, independent of foreign taxes.
- Exception 2: BCAs, quantities supplied to signatory markets only depend on t_i but not on t_j. Only signatory taxes matter!
- No-BCAs: quantities sold to all markets are the same.
- BCAs: market segmentation, sell more to own than foreign markets.

Driving Forces II

$t_i > t_j$

Damages and producers are sufficiently important compared to consumers.

- profits net of taxes lower in signatory than non-signatory countries
- profits of signatories better protected through BCAs
- BCAs generate tax revenues for signatory countries from non-signatory firms
- consumer surplus equal in signatory and non-signatory countries
- consumer surplus lower in signatory countries through BCAs.

Result 1 - Comparing Equilibrium Taxes Across Regimes

Denote equilibrium taxes under both regimes with superscript No-BCA and BCA, respectively, and assume $1 < m < n$.

- *Under the BCA-regime signatories' equilibrium taxes are higher than under the No-BCA-regime:* $t_i^{*BCA} > t_i^{*No-BCA} \; \forall \, m$.
- *Under the BCA-regime non-signatories' equilibrium taxes are higher than under the No-BCA-regime for* $\gamma = \{0, 0.5\}$: $t_j^{*BCA} > t_j^{*No-BCA} \; \forall \, m$. *For* $\gamma = 1$, $t_j^{*BCA} < t_j^{*No-BCA} \forall \, m \leq \tilde{m}$, *and* $t_j^{*BCA} > t_j^{*No-BCA} \; \forall \, m > \tilde{m}$, *with* $\tilde{m}$ *some threshold,* $\tilde{m} < n$.
- *Under the BCA-regime, total output is lower and hence total emissions are lower than under No-BCA-regime for all* m.

producers consumers tax revenues

Criteria for Evaluation

$$m^*$$

$$CGI(m^*) := \frac{\sum_{k \in N} Wq_k(m^*) - \sum_{k \in N} Wq_k(m = 1)}{\sum_{k \in N} Wq_k(m = n) - \sum_{k \in N} Wq_k(m = 1)} \bullet 100$$

Result 2 - Equilibrium Coalitions under Open Membership

Let m^* denote the equilibrium size of a stable coalition under open membership and let $CGI(m^*)$ denote the closing the gap index of stable agreements with m^* members. Then, under the No-BCA- and BCA-regime, we find:

Table 1: Stable Coalitions and Global Welfare under Open Membership

	No-BCA-regime		BCA-regime	
γ	m^*	$CGI(m^*)$	m^*	$CGI(m^*)$
1	1	0	10	100
0.5	2	1	10	100
0	3	7.3	6-9	87.9-99.9

No-BCA-Regime: superadditivity fails for $\gamma = 1$; positive externalities throughout.

BCA-Regime: superadditivity always holds; negative externalities for $\gamma = 1$ and $\gamma = 0.5$ for sufficiently large coalitions and damages not too high.

Signatories welfare is always higher with than without BCAs.

For non-signatories the reverse is generally true for $\gamma = 1$ and $\gamma = 0.5$, and for $\gamma = 0$ it is true for larger coalitions.

Suppose coalition formation does not take place simultaneously but sequentially. Would this make a difference?

Each coalition from $m = 1$ up to m^* needs to be internally stable (nobody wants to leave).

Each coalition up to m^* needs to be externally unstable (non-signatories want to join).

This is the case under both regimes and hence nothing changes.

Suppose membership is exclusive. Would this make a difference?

Consider a sequential process.

As long as signatories' welfare increases with an expansion, they will not object to accession. However, if their welfare drops, they will vote against accession.

Figure 1b: Welfare of Signatories and BCAs

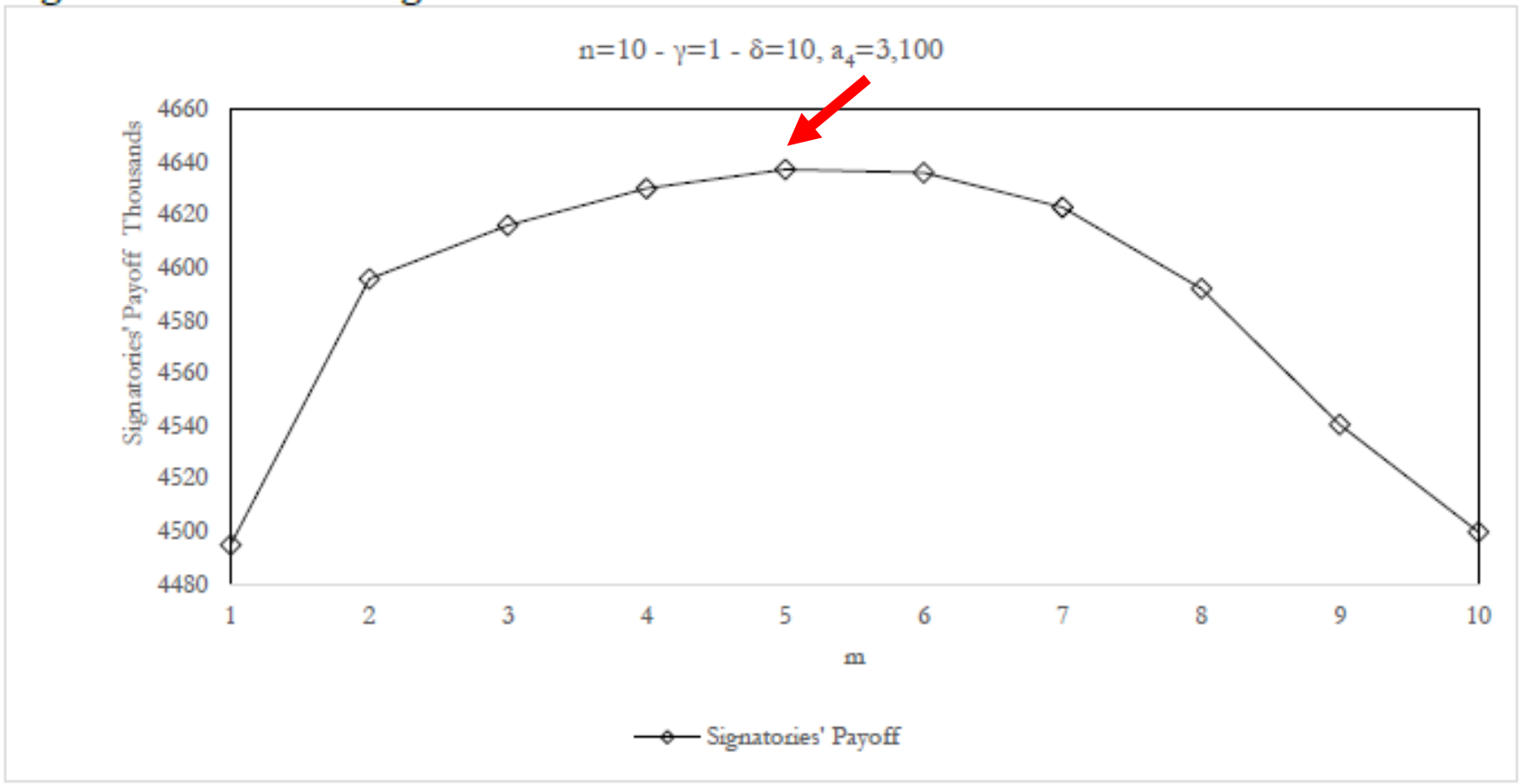
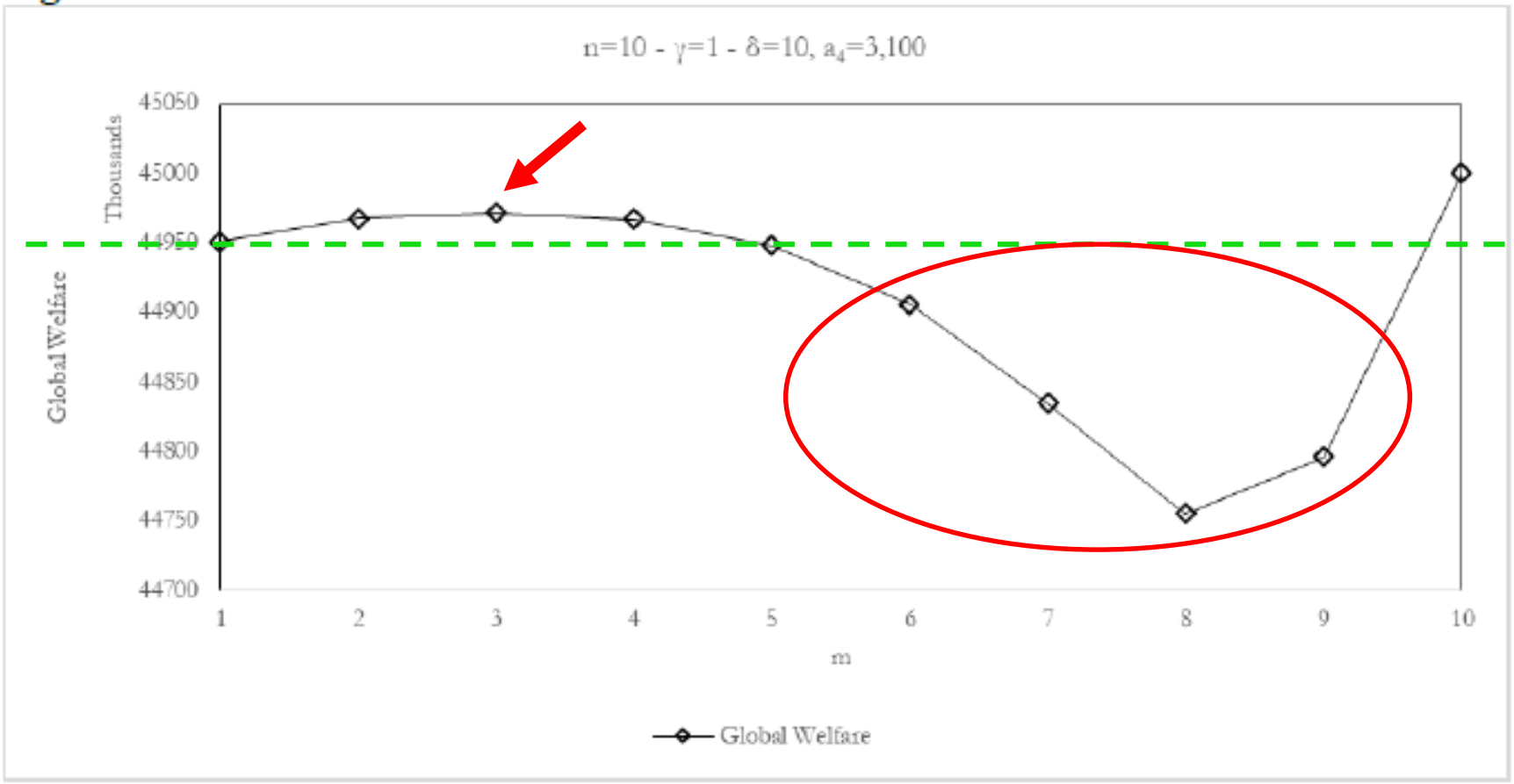


Figure 1c: Global Welfare and BCAs



For $\gamma = 1$ and $\gamma = 0.5$ cohesiveness may fail under the BCA-regime.

If the expansion of the coalition stops before full participation under exclusive membership, global welfare may be low/below the status quo.

Result 3 - Equilibrium Coalitions under Exclusive Membership

Assume exclusive membership. Let m^* denote the size of stable coalition(s) under both regimes and consider a sequential coalition formation process. Then, under the No-BCA- and BCA-regime, we find:

Table 2: Stable Coalitions and Global Welfare under Exclusive Membership

	Parameter a	No-BCA-regime		BCA-regime	
γ		m^*	CGI(m^*)	m^*	CGI(m^*)
1	$a_1(\delta,\gamma)$ to $a_3(\delta,\gamma)$	1	0	9/6/6	98.7/93.5/44.1
	$a_4(\delta,\gamma)$ to $a_6(\delta,\gamma)$	1	0	5/5/5	<0/<0/<0
0.5	$a_1(\delta,\gamma)$ to $a_3(\delta,\gamma)$	2	1	9/8/6	97.3/95.5/78.9
	$a_4(\delta,\gamma)$ to $a_6(\delta,\gamma)$	2	1	6/5/5	<0/<0/<0
0	$a_1(\delta,\gamma)$ to $a_3(\delta,\gamma)$	3	7.3	6/8/8	87.9/97.7/98.0
	$a_4(\delta,\gamma)$ to $a_6(\delta,\gamma)$	3	7.3	9/9/9	99.8/99.9/99.9

Conclusions

- Without BCAs, agreements do not achieve a lot due to strong free-rider incentives and leakage effects.
- With BCAs, signatories can enforce large stable agreements.
- If participation is not close to full participation, BCAs may be associated with large global welfare costs.
- Agreements should be of the open membership type. Exclusive membership should be avoided.

Thanks !