

## **Unilateral Climate Policy Design:**

# ***Efficiency and Equity Implications of Alternative Instruments to Reduce Carbon Leakage***

Christoph Böhringer, Jared C. Carbone, Thomas F. Rutherford

# Overview

- Issue: How good are alternative anti-leakage measures?
  - Border carbon adjustments
  - Output-based allocation of emission allowances
  - Industry exemptions
- Performance metrics:
  - Leakage reduction
  - Output of emission-intensive and trade-exposed (EITE) industries
  - Global cost
  - Cost incidence
- Key finding: None of the measures amounts to a “magic bullet”.

# Mechanisms and Metrics

- Trade-off between second-best gains from leakage reduction and losses due to instrument-specific distortions:
  - Border carbon adjustments: trade distortions
  - Output-based allocation: production distortions (implicit output subsidy)
  - Industry exemptions: non-uniform emission pricing (implicit input subsidy)

# Mechanisms and Metrics

- Social welfare function (SWF) can be used as efficiency and equity metric:

$$SWF = \left( \sum_r \theta_r C_r^{(1-1/\rho)} \right)^{1/(1-1/\rho)}$$

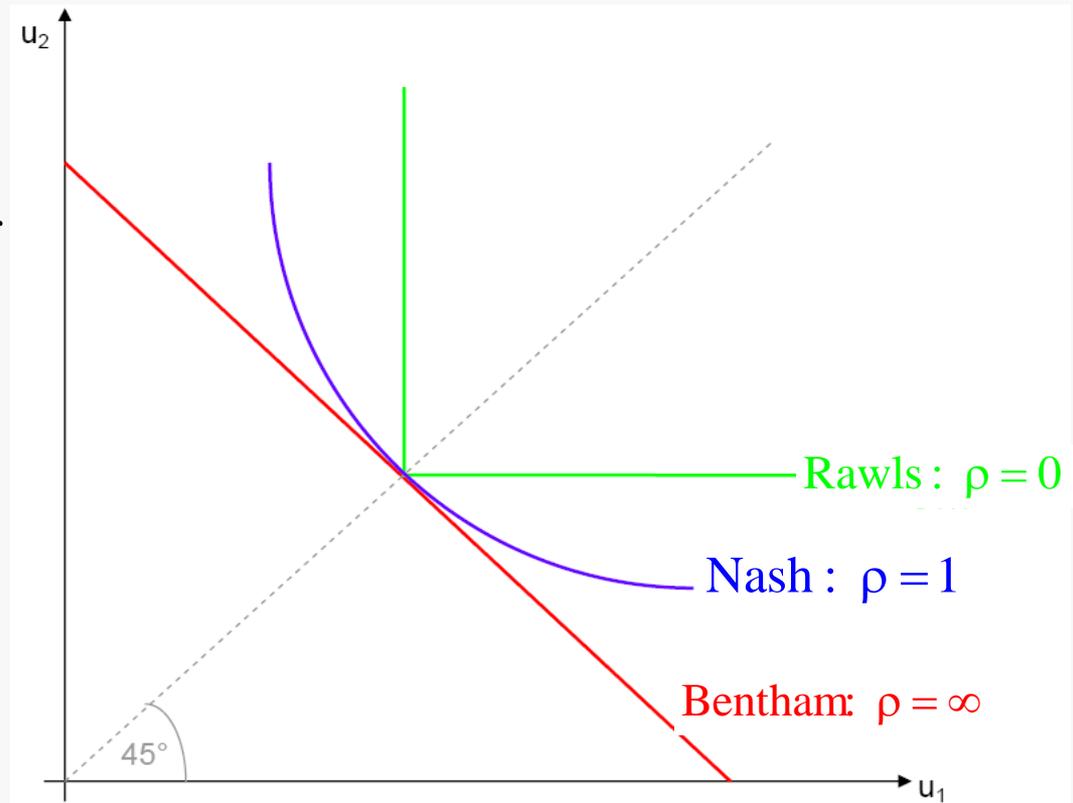
$\rho$  : inequality aversion coefficient

$C_r$  : per – capita welfare in region  $r$

$\theta_r$  : population share of region  $r$

Extreme cases:

- $\rho = \infty$  : utilitarian (Bentham)
- $\rho = 0$  : minmax (Rawls)



# Framework for Assessment

- Model and data:
  - Static multi-sector, multi-region CGE model
  - GTAP7 data
- Sectors and regions:

<i>Sectors and commodities</i>	<i>Countries and regions</i>
<i>Energy goods</i>	<i>Annex 1 (industrialized) regions</i>
Coal (COL)	Europe – EU-27 plus EFTA (EUR)
Crude oil (CRU)	United States of America (USA)
Natural gas (GAS)	Russia (RUS)
Refined oil products (OIL)*	Remaining Annex 1 (RA1)
Electricity (ELE)	
<i>Non-energy goods</i>	<i>Non-Annex1 regions</i>
Chemical products (CRP)*	China (CHN)
Non-metallic minerals (NMM)*	India (IND)
Iron and steel industry (I_S)*	Energy exporting countries excl. Mexico (EEX)
Non-ferrous metals (NFM)*	Other middle income countries (MIC)
Air transport (ATP)	Other low income countries (LIC)
Water transport (WTP)	
Other transport (OTP)	
All other goods (AOG)	

Energy-intensive and trade-exposed industries (EITE)

# Scenario Dimensions

- Policy instruments:
  - **bau**: no climate policy – business-as-usual
  - **ref**: uniform unilateral emission pricing
  - **bca**: *ref* plus border tariffs and rebate to EITE industries (based on carbon content)
  - **oba**: *ref* plus output-based allocation of emission allowances to EITE industries
  - **exe**: *ref* plus exemptions of EITE industries
- Size of abatement coalition:
  - **EUR**: EU-27 and EFTA
  - **A1xR**: Annex 1 countries without Russia
  - **A1xR\_CHN**: China plus Annex1 countries without Russia
- Reduction targets: 10%, 20%, 30% from coalition's business-as-usual level

N.B.: Across all scenarios global emissions are kept constant at the **ref** level!

# Leakage

- Leakage (%):

Emission reduction target (%)		10	20	30
Leakage	<i>Reference (ref)</i>	15,3	17,9	21,0
	<i>Border carbon adjustment (bca)</i>	10,1	11,2	12,6
	<i>Output-based allocation (oba)</i>	13,7	16,0	18,6
	<i>Exemptions (exe)</i>	13,9	16,4	19,4

- Leakage reduction (% from reference scenario **ref**):

Emission reduction target (%)		10	20	30
Leakage reduction	<i>Border carbon adjustment (bca)</i>	33,6	37,2	39,8
	<i>Output-based allocation (oba)</i>	10,4	10,9	11,5
	<i>Exemptions (exe)</i>	9,2	8,5	7,4

# EITE Output

- EITE output (% from business-as-usual *bau*):

Emission reduction target (%)		10	20	30
EITE output	<i>Reference (ref)</i>	-1.0	-2.6	-4.9
	<i>Border carbon adjustment (bca)</i>	-0.2	-0.4	-0.7
	<i>Output-based allocation (oba)</i>	-0.6	-1.6	-3.1
	<i>Exemptions (exe)</i>	-0.6	-1.7	-3.1

- EITE output loss reduction (% from reference scenario *ref*):

Emission reduction target (%)		10	20	30
EITE output	<i>Border carbon adjustment (bca)</i>	80.0	82.8	85.3
	<i>Output-based allocation (oba)</i>	39.7	38.5	37.8
	<i>Exemptions (exe)</i>	37.1	36.7	36.7

# Global Cost

- Global cost (% real consumption change (here: HEV) from *bau*):

Emission reduction target (% from <i>ref</i> )		10	20	30
Global cost	<i>Reference (ref)</i>	-0,058	-0,179	-0,391
	<i>Border carbon adjustment (bca)</i>	-0,052	-0,155	-0,325
	<i>Output-based allocation (oba)</i>	-0,053	-0,164	-0,357
	<i>Exemptions (exe)</i>	-0,054	-0,175	-0,398

- Global cost savings (% from reference scenario *ref*):

Emission reduction target (% from <i>ref</i> )		10	20	30
Global cost savings	<i>Border carbon adjustment (bca)</i>	11,1	13,4	17,0
	<i>Output-based allocation (oba)</i>	8,9	8,3	8,8
	<i>Exemptions (exe)</i>	6,4	2,0	-1,6

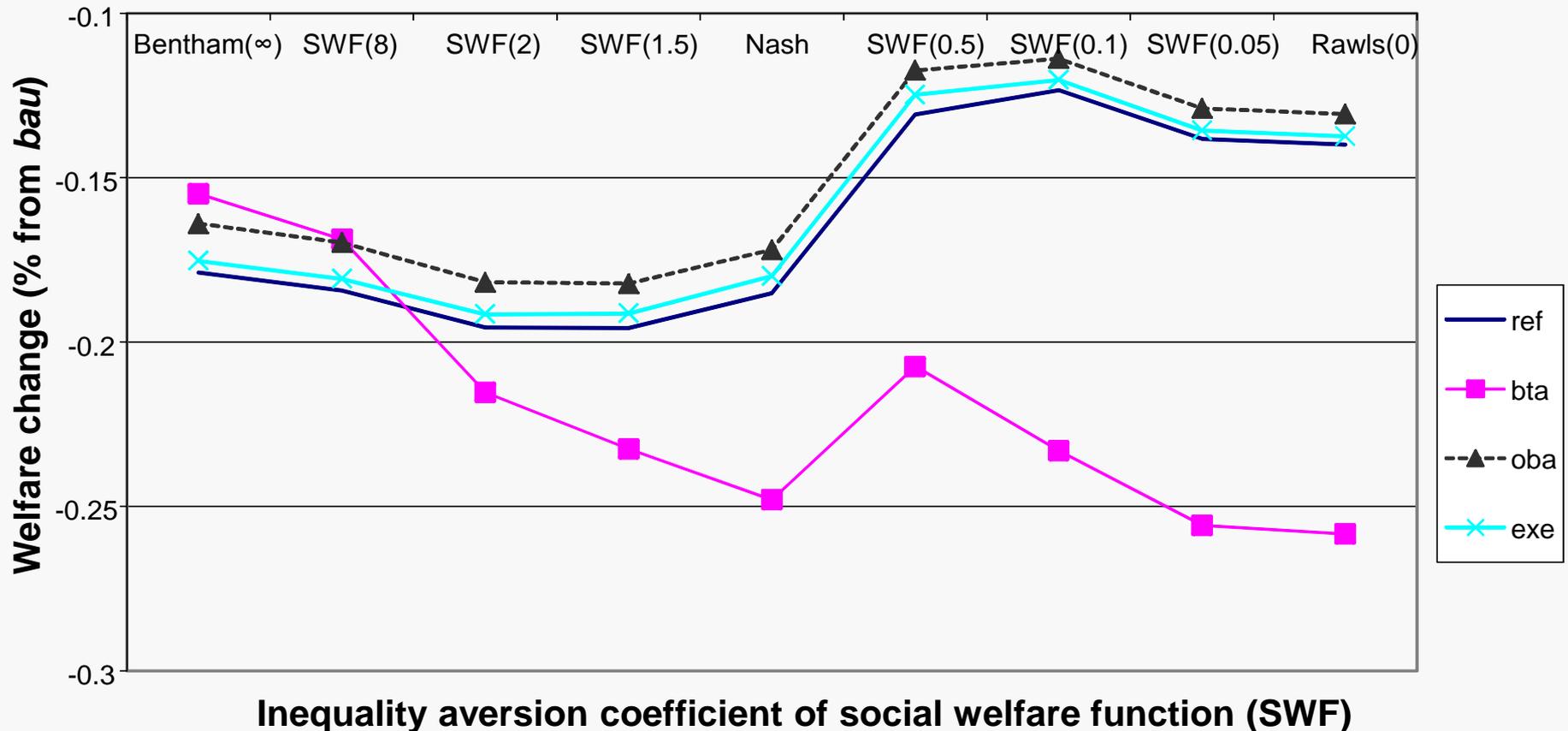
# Burden Sharing (Shifting)

- Burden sharing ratio between coalition and non-coalition\*  
\* calculated as cost of abatement coalition relative to cost of non-coalition

Emission reduction target (%)		10	20	30
Leakage	<i>Reference (ref)</i>	2,4	3,3	4,3
	<i>Border carbon adjustment (bca)</i>	1,1	1,6	2,1
	<i>Output-based allocation (oba)</i>	2,2	3,1	4,0
	<i>Exemptions (exe)</i>	2,3	3,2	4,1

# Cost Incidence

- Global welfare change (% HEV from *bau*) as a function of inequality aversion



# Conclusion

- None of the anti-leakage measures amounts to a “magic bullet”!
  - Border carbon adjustments reduce leakage as well as EITE output losses quite effectively and provide substantial global cost savings but they exacerbate regional inequality.
  - Exemptions produce are much less effective in leakage reduction and attenuation of EITE output losses. They have weak re-distributional impacts but run the risk of even increasing climate policy.
  - Alike exemption, output-based allocation are less effective in leakage reduction and attenuation of EITE output losses. They provide modest global cost savings without affecting the cost incidence of unilateral abatement action markedly.