Output-based rebating of carbon taxes

when playing with others:

competitiveness and welfare considerations

by

Christoph Böhringer, Brita Bye, Taran Fæhn, and Knut Einar Rosendahl
Introduction

Lack of first-best global policy to curb GHG emissions:

– Several jurisdictions carry out unilateral climate policies
– Their major concerns:
  - Risk loss of market shares/competitiveness in international markets
  - Risk increased GHG emissions from foreign firms that counteract abatement at home – carbon leakage

Second-best, unilateral instruments have been proposed:

– Border Carbon Adjustments (BCA)
  = tariffs on carbon content of net imports
If well-designed, the most targeted towards leakage – but:
  legal and political obstacles, administration costs
– Output-Based Rebating rules (OBR)
  = rebate carbon tax payments in proportion to output
Almost as effective against leakage, more feasible to subsidize and to operate domestically
Our contribution

Large literature on the performance of OBR

• theoretical and numerical analyses

• some influential papers

Our contribution:

• Significance of carbon tax and OBR policies abroad for the choice of domestic OBR policy

• Theoretical and numerical results

OBR and tax \approx OBA and cap \approx tradable unit emission permits

– Price incentives to reduce unit emissions
– But avoid output drops
– Our analysis relevant for several existing and proposed systems
METHOD

a) Theoretical analysis

Design

Partial model of the EITE market

3 regions H, F, R

H has a carbon tax

Accounts for possible price effects across borders if H sufficiently large, induce terms of trade eff.

b) Numerical analysis

Design

SNoW model (Statistics Norway World model)

Static, GTAP data-based, CGE model

3 regions: Canada (H), USA (F), RoW (R)

Welfare = Hicksian equiv. variation + evaluation of global abatement

More effects:

• All sectors face carbon tax,

• Intermediates induce input-output-effects – also across borders via imported intermediates,

• Possible tax interaction effects
POLICY GOAL 1: RESTORE COMPETITIVENESS

Theoretical results:

\( \text{OBR}^H: \) Competitiveness improves more the higher the substitutability between the H and FR products (counteracted if decreasing returns to scale effects on costs or foreign price reds (large H))

\( \text{TAX}^F: \) H competitiveness improves and \( \text{OBR}^H \)-rate needed to restore it, falls more the higher the substitutability (cross-price elasticities) and more the higher the emission intensity in F

\( \text{OBR}^F: \) H competitiveness decreases and \( \text{OBR}^H \)-rate necessary to restore it increases more the higher the substitutability (cross-price elasticities)

Numerical results:

Replicates the partial results:
Output effects for Canadian EITE industries (in % from BaU) under
• different OBR\textsuperscript{H} -rates and
• three alternative assumptions about US climate policy

![Graph showing output effects for Canadian EITE industries under different OBR\textsuperscript{H} rates and alternative US climate policy assumptions.]
Output effects for detailed Canadian EITE industries (in % from BaU) under
• different OBR\textsuperscript{H} -rates and
• three alternative assumptions about US climate policy
Some industry details

OBR\textsuperscript{H}:
More than 100\% OBR\textsuperscript{H} needed - not well-designed for compensating for indirect cost increases (input prices):

\textit{NON-FERROUS METALS}: use electricity

\textit{OIL REFINING}: use crude oil

\textbf{TAX}\textsuperscript{F}:

\textit{NON-METALLIC MINERALS}: Large benefit for CAN because high emission intensity in US

\textbf{OBR}\textsuperscript{F}:

\textit{NON-METALLIC MINERALS}: Adverse effect, as US a significant competitor (\textit{subsitutability})

\textit{NON-FERROUS METALS}: Insignificant effect, as input-output effects in US not well compensated
OPTIMAL OBR RATES

Theoretical results:

\[ \text{Marginal costs of } OBR^H = \text{Marginal net benefits of } OBR^H \]
\[ \text{Marginal change in the efficiency wedge in the domestic market, the } OBR^H \text{ rate} = \text{The value of avoided emissions abroad when domestic output marginally increases} \]

In addition: Possible terms-of-trade costs of reduced export prices (or gains)

Avoided emissions abroad increase with same factors as competitiveness:

- substitutability and foreign emission intensities

Foreign policy: Works through effect on emission intensity in F

- \( \text{TAX}^F \) decreases emission intensity in F -> optimal \( OBR^H \) rate falls
- \( OBR^F \) no direct effect on emission intensity in F -> small, ambiguous effect on \( OBR^H \)

Numerical results:

In a CGE setting less predictable effects:

- Welfare also affected by input-output effects and tax interactions……
- Canada is large enough to affect foreign prices – uncertain terms of trade effects
- Optimal rates can be lower than 0 and higher than 100%
Welfare effects for Canada (% from BaU) under
• different OBR\textsuperscript{H} -rates and
• three alternative assumptions about US climate policy
Sensitivity analysis of substitutability

Substitution elasticities between products of different origins (Armington elasticities) are very uncertain!

Higher substitutability -> OBR more beneficial
- Output and emissions abroad respond more
- Foreign (import) prices drop more, i.e. (gross) terms-of-trade gains

We increase Armington elasticities 50%
- Optimal OBR rate for EITE exceeds 200% irrespective of US
Conclusions

Do US carbon policies matter for the Canadian choice of OBR?

(i) The necessary OBR to compensate for the total effect of both own and US policies generally fall with US carbon policies, and most so if the US refrains from OBR.

(ii) Industries vary considerably wrt. the compensatory OBR rate and the influence of US policies – and there are complex explanations, difficult to give general policy recommendations.

(iii) The optimal OBR rates for Canada decrease only slightly when the US introduces carbon tax, and are virtually unaffected by US OBR policies.

(iv) Missing the optimal OBR level has but minor welfare implications - moreover: Whatever the OBR level, welfare effects are small.

(v) Main conclusion: No clear trade-off between welfare and other OBR motives.

(vi) The substitutability between Canadian and US goods are much more important for the optimal OBR rates. Challenge: Estimate relevant and accurate substitution parameters.
Thank you for your attention

tfn@ssb.no
Numerical simulations

Carbon policies to Energy-Intensive and Trade-Exposed (EITE) industries (five industries)

Scenarios:

Home (Canada):

• Business-as-usual BaU (no carbon policies)
• Unilateral carbon tax (30 USD)
• Unilateral carbon tax (30 USD) combined with OBR scheme refunds of xc%. We examine different levels of xc (20%, 40%, 60%, 80%, 100%)

These scenarios are calculated under three different policy scenarios for the US (foreign):

- BaU (no carbon policies)
- Carbon tax (30 USD) without OBR (xu=0)
- Carbon tax (30 USD) with full OBR (xu=100%)
Figure 1. Percentage changes in Canadian EITE output under different OBR-rates for Canada and different assumptions about US climate policy.
Figure 2. Percentage changes in Canadian output of the five EITE goods, under different OBR-rates for Canada and different assumptions about US climate policy.
Figure 3. Carbon leakage due to Canadian climate policies, under different OBR-rates for Canada and different assumptions about US climate policy.
Figure 2. Percentage changes in Canadian output of the five EITE goods, under different OBR-rates for Canada and different assumptions about US climate policy.
Figure 5. Welfare changes in Canada, including the value of reduced global emissions, under different Canadian OBR-rates and different US climate policies. %-change from BaU
Sensitivity-analyses

• Higher substitution elasticity between domestic and foreign goods in the EITE industries
  – More substitution and smaller terms-of-trade effects – the second-best optimal OBR in Canada increases – independent of US policies
  – Substitutability of EITE goods is much more important for the optimal OBR-rate in Canada than the climate policies implemented in US

• More sensitivities to come……..
Concluding remarks

• Second-best unilateral carbon policies with carbon taxation combined with OBR rates reduce carbon leakage and lower the costs for EITE industries, compared to only taxing carbon.

• US carbon policies have notable effects on Canadian EITE output under different Canadian carbon policies.

• Large differences in policy effects between EITE industries, both with
  – Canadian unilateral policies
  – Interplay with US carbon policies

• Substitutability (terms-of-trade effects) between domestic and foreign EITE goods is much more important for the optimal OBR rate in Canada than the climate policies implemented in the US
  – The larger the substitutability (smaller terms-of-trade effects) the larger the second-best optimal OBR rate.

• The study provides knowledge of optimal and feasible policies in still not regulating countries.
Thank you

bby@ssb.no
Second-best policies

• Border carbon adjustments
  – Import tariffs and export rebates on the carbon embodied in trade for the regulating countries (Hoel, 1996)
    ◦ Less targeted (goods - not emissions)
    ◦ Less comprehensive (traded goods, only)
    ◦ Difficult to obtain correct numbers on emission intensities in foreign non-regulating jurisdictions
    ◦ Controversial from a free trade perspective
    ◦ Not very effective in terms of welfare gain and leakage reduction if import tariffs are only based on domestic emission coefficients compared to only fully auctioned quotas (Böhringer et al, 2012)

• Output-based rebating rules
  – Less controversial from a free-trade perspective
  – Only based on domestic measures – easier to obtain correct numbers
  – Most studies are based on 100% rebating
CARBON LEAKAGE

Carbon Leakage (%) = \( \frac{\text{Emission increase in other countries}}{\text{Emission cuts in regulating country}} \) (100%)

Typical findings in the literature:
- Carbon Leakage of 10 - 30%
- Falling with the size of the coalition

Two main channels:

**Competitiveness/trade effect:**
Energy-intensive, trade-exposed (EITE) firms in regulated countries move/lose market shares to competitors in non-regulated countries
-> Emissions are relocated (depend on effects on prices, elasticities, emission intensities)

**Energy market/price effects:**
Lower energy demand in regulated countries reduces world market prices of energy.
-> Energy demand abroad – and emissions - increase (supply responses counteract)

Typical finding: Energy market effect the stronger

Note: Output-based rebates will only have *direct* influence on competitiveness effect
Method: VENT MED DET

- Theoretical model analysis
  - Partial market model
- Numerical CGE simulations (the SNoW model)
  - Canada the example – the US the larger trading partner
  - Canadian proposal: unit emission permits – if tradable = OBR

Canada’s turning the corner proposal: unit emission permits

Peters: Canadas emissions in trade larger than the US’
The SNoW Model

Statistics Norway World Model

CGE model - global trade and energy GTAP (2007) data set

- Three regions: Canada, USA, Rest of the World – RoW)
- Factor inputs: capital, labour, energy, materials
- Capital and labour intersectorally mobile, immobile between regions
- Final consumer demand is derived from a representative agent in each region that maximises welfare s.t. budget constraints
- Bilateral trade is specified as differentiated goods (Armington)
- CO2-emissions are linked to the use of fossil fuels with constant CO2-coefficients differentiated by the carbon content of the different fuels
Literature background

Competitiveness
- Peters and Hertwich (2008): Canada’s trade is more emission intensive than the US’
- Goulder (2001): Competitiveness can easily (cheaply) be restored with rebating
- Dissou (2006): Large heterogeneity – serious competitiveness effects of carbon policies

Optimal rebate rates (welfare when global abatement is valuated)
- Increase with substitutability and foreign emission intensities (Bernard et al., 2007)
- Increase with indirect emissions abroad
- Tax interactions (Lennox and Nieuwkoop, 2010) and terms-of-trade effects
- Can be lower than 0 and higher than 100%

Our contribution:
- The significance of carbon tax and OBR policies abroad for domestic OBR rates?
Theoretical background and previous literature

Competitiveness

- Peters and Hertwich (2008): Canada’s trade is more emission intensive than the US’
- Goulder (2001): Competitiveness can easily (cheaply) be restored with rebating
- Dissou (2006): Large heterogeneity – serious competitiveness effects of carbon policies

Optimal rebate rates (welfare when global abatement is valuated)

- Increase with substitutability and foreign emission intensities (Bernard et al., 2007)
- Increase with indirect emissions abroad
- Tax interactions (Lennox and Nieuwkoop, 2010) and terms-of-trade effects
- Can be lower than 0 and higher than 100%

Our contribution:

- The significance of carbon tax and OBR policies abroad for domestic OBR rates?
Research questions:

• How to choose OBR rates for Energy-Intensive, Trade-Exposed industries (EITE) when
  – AIM 1) Restore competitiveness of EITE
  – AIM 2) Welfare maximization = trade-off benefits and costs (OBR ensures higher global abatement, but distorts the EITE markets + other aspects)

• How considerations are affected when the neighbor acts