Nationally determined carbon emissions caps and moral consumers

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Introduction

- in recent years the awareness increased of a need to curb climate change
- people make efforts to reduce their carbon foot-print
- homo oeconomicus would refrain from such action
- standard model of self-interested agents fails to explain voluntary carbon emissions reduction

Introduction

- two different lines: behavioral economics or Kantian ethics
- moral preferences with respect to the consumption of fossil energy
- consumer focus on "doing the right thing"
- concept goes back to Alger and Weibull (2013, Econometrica)
- two polar cases: consumer with morality 0 (homo oeconomicus), consumer with morality 1 (Kantian)

Introduction

- moral individuals consume the less, the higher is their degree of morality
- consumers differ with respect to their degree of morality, morality is not 1 at all of them
- how translates their inclination "to do the right thing" into their government's climate policy?
- two-country model, two internationally traded goods, each country produces and consumers both goods; consumers suffer from climate damage (caused by energy consumption)

Introduction

- benchmarks: BAU, social optimum
- benevolent governments, governments that are elected under majority rule
- strategic delegation, government candidates propose their emissions cap conditional on the other country's emissions cap or policymaker

Voters and governments take as given . . .		
prices	the other country's emissions cap	the other country's policymaker
YES	*P*-governments	*DP*-governments
NO	*S*-governments	*DS*-governments

Table: Alternative politico-economic equilibria

Introduction

- paper is related to different strands in the literature
- climate policy without moral consumers (Hoel, 1991, Kiyono and Ishikawa 2013)
- strategic delegation in two-country models with environmental policy (Siqueira 2003, Roelfsema 2007)
- Kantian preferences (Alger and Weibull 2013, 2016, 2019)
- Kantian equilibrium (Roemer 2010, Grafton et al. 2017)
- Social norms (Brekke et al. 2003, Wirl 2011)

Efficiency versus business as usual (BAU)

The model

- two countries (foreign *), $i = 1, \ldots, n$ consumers (different with respect to morality)
- fossil energy (supply x, demand y)
- consumption good (supply z^s, demand z^d)

$$z^s = T(x) = \bar{r} - C(x) \tag{1}$$

- utility of individual i

$$B(y_i) + z_i^d - H\left(\sum_j y_j + \sum_j y_j^*\right) \tag{2}$$

Efficiency versus business as usual (BAU)

The model

- resource constraint

$$x + x^* = \sum_j y_j + \sum_j y_j^* \quad \text{and} \quad z^s + z^{*s} = \sum_j z_j^d + \sum_j z_j^{*d} \qquad (3)$$

- sometimes parametric functions

$$B(y_i) = ay_i - \frac{b}{2}y_i^2, \quad C(x) = \frac{c}{2}x^2, \quad H\left(\sum_j y_j + \sum_j y_j^*\right) = \left(\sum_j y_j + \sum_j y_j^*\right)h \qquad (4)$$

Efficiency versus business as usual (BAU)

Efficiency

Social planner maximizes sum of utilities subject to (3)

symmetry: $x = x^* = ny_i = ny_i^*$

$$B'(y_i) - C'(ny_i) - 2nH'(2ny_i) = 0$$

Efficiency versus business as usual (BAU)

BAU

Consumer i's budget constraint

$$z_i^d + (p+q)y_i = \omega \tag{5}$$

energy demand: $y_i = D(p+q, \kappa_i)$; energy supply $x_i = S(p)$; energy market equilibrium

$$\sum_j D(p+q, \kappa_j) + \sum_j D^*(p+q^*, \kappa_j^*) = S(p) + S^*(p) \tag{6}$$

for $q = q^* = 0$

Efficiency versus business as usual (BAU)

BAU

material utility of homo oeconomicus

$$V\left(y_i, \sum_j y_j + \sum_j y_j^*\right) := B(y_i) + \omega - (p+q)y_i - H\left(\sum_j y_j + \sum_j y_j^*\right) \quad (7)$$

material utility of homo kantiensis

$$\tilde{V}(y_i) := B(y_i) + \omega - (p+q)y_i - H(2ny_i) \quad (8)$$

Efficiency versus business as usual (BAU)

BAU

moral utility

$$U\left(y_i, \sum_j y_j + \sum_j y_j^*, \kappa_i\right) := (1-\kappa_i)V\left(y_i, \sum_j y_j + \sum_j y_j^*\right) + \kappa_i \tilde{V}(y_i)$$
$$= B(y_i) + \omega - (p+q)y_i - (1-\kappa_i)H\left(\sum_j y_j + \sum_j y_j^*\right) - \kappa_i H(2ny_i)$$

κ_i: degree of morality

BAU allocation rule

$$B'(y_i) - C'\left(\sum_j y_j\right) - 2\kappa_i n H'(2ny_i) = 0$$

Efficiency versus business as usual (BAU)

Proposition 1.

(i) *In BAU total emissions*

- *are largest iff* $\kappa_i = \kappa_i^* = 0$
- *are the smaller, the larger* $\kappa_\mu := \frac{\sum \kappa_j}{n}$,
- *are efficient, iff* $\kappa_i = \kappa_i^* = 1$.

(ii) *If the consumers' moralities are dispersed in BAU,*

- *a Kantian consumer's material utility is lower than at efficiency;*
- *an economic consumer's material utility is higher than at efficiency, if the morality of the other consumers is sufficiently high.*

Emissions cap policy

National ETs with given emissions caps

Fuel market equilibrium

$$\bar{y} + \bar{y}^* = 2S(p) \quad \Longrightarrow \quad P(\bar{y}, \bar{y}^*) \tag{9}$$

Permit market equilibrium

$$\bar{y} = \sum_j D[P(\bar{y}, \bar{y}^*) + q, \kappa_j] \quad \Longrightarrow \quad Q(\bar{y}, \bar{y}^*, \kappa_i) \tag{10}$$

Finally,

$$y_i D[P(\bar{y}, \bar{y}^*) + Q(\bar{y}, \bar{y}^*, \kappa_i), \kappa_j] \tag{11}$$

determines consumer i's energy demand $Y(\bar{y}, \bar{y}^*, \kappa_i)$, $Y^*(\bar{y}, \bar{y}^*, \kappa_i^*)$

Emissions cap policy

National ETs with given emissions caps

indirect utility

$$U(\bar{y},\bar{y}^*,\kappa_i) \equiv (1-\kappa_i)V(\bar{y},\bar{y}^*,\kappa_i) + \kappa_i \tilde{V}(\bar{y},\kappa_i), \tag{12}$$

where

$$\begin{aligned} V(\bar{y},\bar{y}^*,\kappa_i) &= B\left[Y(\bar{y},\bar{y}^*,\kappa_i)\right] + \omega(\bar{y},\bar{y}^*,\kappa_i) - \left[P(\bar{y},\bar{y}^*) + Q(\bar{y},\bar{y}^*,\kappa_i)\right] Y(\bar{y},\bar{y}^*,\kappa_i) \\ &\quad -H(\bar{y}+\bar{y}^*), \qquad (13) \\ \tilde{V}(\bar{y},\kappa_i) &= B\left[\tilde{Y}(\bar{y},\kappa_i)\right] + \tilde{\omega}(\bar{y},\kappa_i) - \left[\tilde{P}(\bar{y}) + \tilde{Q}(\bar{y},\kappa_i)\right] \tilde{Y}(\bar{y},\kappa_i) \\ &\quad -H\left(2n\tilde{Y}(\bar{y},\kappa_i)\right), \qquad (14) \\ \omega(\bar{y},\bar{y}^*,\kappa_i) &= \frac{1}{n}\left\{\bar{r} - C\left[S(P(\bar{y},\bar{y}^*))\right] + P(\bar{y},\bar{y}^*)\cdot S(P(\bar{y},\bar{y}^*)) + Q(\bar{y},\bar{y}^*,\kappa_i)\bar{y}\right\}, \qquad (15) \\ \tilde{\omega}(\bar{y},\kappa_i) &= \frac{1}{n}\left\{\bar{r} - C\left[S(\tilde{P}(\bar{y}))\right] + \tilde{P}(\bar{y})\cdot S(\tilde{P}(\bar{y})) + \tilde{Q}(\bar{y},\bar{y}^*,\kappa_i)\bar{y}\right\}, \qquad (16) \end{aligned}$$

Emissions-cap policies

Benevolent governments objective function

$$\sum_j U(\bar{y}, \bar{y}^*, x_i) = \sum_j \left[(1-\kappa_j)V(\bar{y}, \bar{y}^*, x_j) + \kappa_j \bar{V}(\bar{y}, x_j)\right]$$

First order condition

$$\sum_j U_{\bar{y}}(\bar{y}, \bar{y}^*, \kappa_j) =$$

$$= \sum_j \underbrace{\frac{1}{n}\left[(1-\kappa_j)Q + \kappa_j \tilde{Q}\right]}_{=\text{MBZ}^j} - \sum_j \underbrace{\left[(1-\kappa_j)\text{PE}^j + \kappa_j \tilde{\text{PE}}^j\right]}_{=\text{MBPE}^j} - \sum_j \underbrace{(1-\kappa_j)H'(\bar{y}+\bar{y}^*)}_{=\text{MC}^j} = 0, \quad (17)$$

where

$$\text{PE}^i := \left(Y^i - \frac{S(P)}{n}\right) P_{\bar{y}} + \left(Y^i - \frac{\bar{y}}{n}\right) Q_{\bar{y}}, \quad \tilde{\text{PE}}^i := \left(\tilde{Y}^i - \frac{S(\tilde{P})}{n}\right) \tilde{P}_{\bar{y}} + \left(\tilde{Y}^i - \frac{\bar{y}}{n}\right) \tilde{Q}_{\bar{y}} \qquad (18)$$

Emissions-cap policies

Benevolent government

MBZ^i:	transfer from permit revenues $\frac{q\bar{y}}{n}$
$MBPE^i$:	price effects $= 0$
MC^i:	marginal benefit
	in a symmetric Nash equilibrium

$$B'(y_i) - C'(\bar{y}) - 2\kappa_i nH'(2ny_i) - (1 - \kappa_\mu)\, nH'(2\bar{y}) = 0$$

$\kappa_\mu \uparrow$ has two effects (i) energy demand $\sum_j y_j \downarrow$, (ii) relative to BAU less climate damage is internalized $\bar{y} \uparrow$

Emissions-cap policies

Proposition 2 (Benevolent moral governments).

(i) $y^E < \bar{y}^W < y^{BAU}$.

(ii) *In the parametric economy, the benevolent government's emissions cap* $\bar{y}^W$ *is decreasing in* κ_μ.

Emissions-cap policies

Governments elected by majority rule

Voter's take emissions caps as given

$maxU(\bar{y}, \bar{y}^*, x_i)$

$$U_{\bar{y}}(\bar{y}, \bar{y}^*, \kappa_m) = \\ = \underbrace{\frac{1}{n}\left[(1-\kappa_m)Q + \kappa_m \tilde{Q}\right]}_{=\mathrm{MBZ}^m} - \underbrace{[(1-\kappa_m)\mathrm{PE}^m + \kappa_m \tilde{\mathrm{PE}^m}]}_{=\mathrm{MBPE}^m} - \underbrace{(1-\kappa_m)H'(\bar{y}+\bar{y}^*)}_{=\mathrm{MC}^m} = 0 \quad (19)$$

Symmetric Nash equilibrium

$$B'(y_i) - C'(\bar{y}) - 2\kappa_i nH'(2ny_i) - n\mathrm{PE}^m - (1-\kappa_m)nH'(2\bar{y}) = 0$$

Emissions-cap policies

Proposition 3 (Governments elected by majority rule).

In the parametric economy $R^P(\bar{y}^*, \kappa_m)$ *and* $R^s(\bar{y}^*, \kappa_m)$ *satisfy*

(i) $R^P_{\bar{y}}, R^S_{\bar{y}} \quad \in]-1, 0[$, *strategic substitutes*

(ii) $R^P_{\bar{y}} < R^S_{\bar{y}}$

(iii) $R^P_{\kappa_\mu} < 0, \quad R^P_{\kappa_m} > 0$ *(in the relevant range)*

(iv) $R^S_{\kappa_\mu} = 0, \quad R^S_{\kappa_m} < 0$

P-governments: $\kappa_\mu \uparrow$*: energy demand* $\sum_j y_j \downarrow$

$\kappa_m \uparrow$*: relative to BAU less climate damage is internalized* $\bar{y} \uparrow$

S-governments: additional price effects

Emissions-cap policies

$$B'(y_i) - C'(\bar{y}) - 2\kappa_i nH'(2ny_i) - (1-\kappa_m)nH'(2\bar{y}) = 0$$
$$B'(y_i) - C'(\bar{y}) - 2\kappa_i nH'(2ny_i) - (1-\kappa_\mu)nH'(2\bar{y}) = 0$$

Assumption: $\kappa_\mu > \kappa_m$

Proposition 4 (Price-taking median-voter governments (=P-governments)).

(i) $y^E < \bar{y}^P < \bar{y}^W < y^{BAU}$.

(ii) *In the parametric economy with P-governments, the cap $\bar{y}^P$ is decreasing in the mean morality κ_μ but increasing in the median morality κ_m.*

Emissions-cap policies

Additional price effects: $n\mathrm{PE}^m < 0$, $\bar{y} \uparrow$

Proposition 5 (Strategic median-voter governments (= S-governments)).

(i) *In the economy with S-governments, it holds* $\bar{y}^S > \bar{y}^P > y^E$.

(ii) *In the parametric economy, it holds*

(a) $\bar{y}^S$ *is independent of* κ_μ*, but decreasing in* κ_m*;*

(b) $\bar{y}^S > \bar{y}^W > \bar{y}^P > y^E$*;*

(c) $\bar{y}^S < y^{BAU}$*, iff* $1 + \kappa_m > 2\kappa_\mu$.

Emissions-cap policies

Governments elected by majority rule

- voters take the other country's policymaker as given (strategic delegation)
- Home's voter i anticipates that the foreign policymaker with κ_g^* sets $R^g(\bar{y}, \kappa_g)$ (before $\bar{y}$)

emissions cap: marg. climate damage $H'(\bar{y} + \bar{y}^*)\mathrm{d}\bar{y}$

policymaker: marg. climate damage $H'(\bar{y} + R^{*g})\underbrace{(1 + R_{\bar{y}}^{*g})}_{<1}\mathrm{d}\bar{y}$

marginal climate damage $\downarrow$, $\bar{y} \uparrow$

voter i's favorite cap

$$\hat{R}^{\rho}(\kappa_g^*, \kappa_i) := \underset{\bar{y}}{\operatorname{argmax}}\, U[\bar{y}, R^{*\rho}(\bar{y}, \kappa_g^*), \kappa_i] \tag{20}$$

Emissions-cap policies

Governments elected by majority rule

- Strategic delegation

$$\bar{y}^{D\rho} = \hat{R}^{\rho}(\kappa_D^{*\rho}, \kappa_m) = R^{\rho}[\hat{R}^{\rho}(\kappa_D^{\rho}, \kappa_m^{*}), \kappa_D^{\rho}]$$

Emissions-cap policies

Governments elected by majority rule

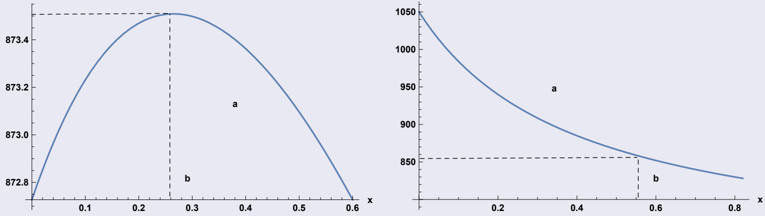

Figure: The reaction functions $\hat{R}^S(\kappa_g^*, \kappa_m)$ and $\hat{R}^P(\kappa_g^*, \kappa_m)$ for a numerical example

Emissions-cap policies

Governments elected by majority rule

Symmetric Nash equilibrium

$$B'(y_i) - C'(\bar{y}) - 2\kappa_i nH'(2ny_i) - n\mathrm{PE}^m \\ -(1-\kappa_m)nH'\left(\bar{y} + R^{*S}(\bar{y},\kappa_g)\right)(1+R_{\bar{y}}^{*S}) = 0$$

Proposition 6 (Governments with delegation).

Suppose that voters take the other government's best-reply function (rather than the other government's emissions cap) as given, and emissions caps are strategic substitutes, then it holds

(i) $\bar{y}^{DP} > \bar{y}^P > y^E$;

(ii) $\bar{y}^{DS} > \bar{y}^S > \bar{y}^P > y^E$.

Emissions-cap policies

Proposition 7 (Governments elected by majority rule).

Consider the parametric economy and suppose voters and governments take the other country's policymaker as given.

(i) *The* $\begin{Bmatrix} DP \\ DS \end{Bmatrix}$ *-government's delegate has the morality* $\begin{Bmatrix} \kappa_D^P > \kappa_m \\ \kappa_D^S < \kappa_m \end{Bmatrix}$.

(ii) $\bar{y}^{DP} < y^{BAU}$.

Emissions-cap policies

Governments elected by majority rule

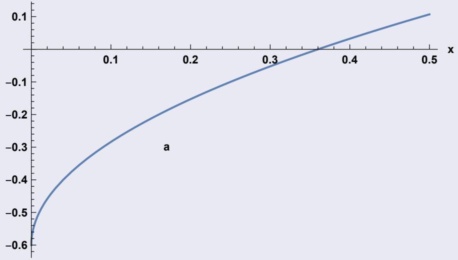

Figure: The difference $y^{BAU} - \bar{y}^{DS}$, when n is large

Emissions-cap policies

Governments elected by majority rule

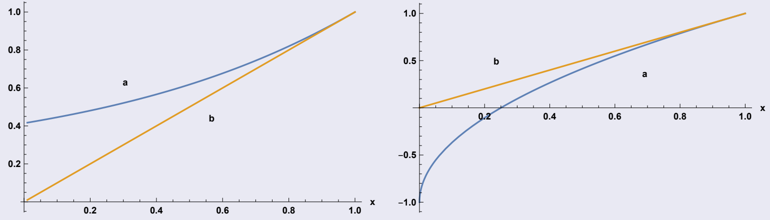

Figure: The difference $\kappa_m - \kappa_D^\rho$ for alternative values of κ_m, if n is large.

Concluding remarks

- the emissions caps are (still) suboptimally large
- the inefficiency gap is the smallest, if governments take prices as given
- the inefficiency gap is the largest, if they combine price manipulation with strategic delegation
- there are cases in which the outcome of governmental action is even worse then in the absence of climate policy
- robustness, simplifying assumptions, e.g. consumers are alike except their degree of morality.

Concluding remarks

Thank you for your attention!