Protecting the environment: On the interplay between voluntary contributions and public policy

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Motivation

- Recent OECD household survey reveals:
  - 14% drive a fully electric car (urban areas)
  - 19% use electricity generated from renewables
  - 23% save energy for environmental reasons
- Yet, the dominant role in environmental protection is still played by governments
- Some policies receive public support, while others do not

Research Question

Can individual pro-environmental behavior increase public support for environmental policies and improve environmental quality in the long run?

Answer helps determine if advocating for personal actions to fight climate change is worthwhile

Our Approach

- Our approach treats environmental quality as a public good
- Its provision is affected over time by:
  - economic development
  - individuals' voluntary contributions
  - environmental policy
- Voluntary contributions are morally motivated
- Policy decision is made on behalf of all individuals alive

Related Literature

- Static partial-equilibrium approach
  - Nyborg et al. (2006), Daube & Ulph (2016), Wichman (2016), Ambec & De Donder (2022)
- Static general-equilibrium approach
  - Perino (2015)
- Dynamic general-equilibrium approach
  - Ballet et al. (2007), Dam & Heijdra (2011), Fodha & Seegmuller (2012), Bezin (2015), Constant & Davin (2018)

Our contribution: dynamic general-equilibrium model with overlapping generations and multiple environmental measures

Results and Mechanisms

1. **Stimulating voluntary contributions via subsidies may be infeasible due to intergenerational conflict**
    - "Young", who make contributions, favor subsidies; "old" prefer no pollution tax, which is higher with subsidies

2. **In the long run, voluntary contributions undermine public support for government abatement**
    - Gov. abatement crowds out contributions, reducing warm glow from them and their environmental impact
    - Contributions divert resources from capital formation, increasing the costs of gov. abatement in the future

Results and Mechanisms (cont'd)

3. **In the long run, voluntary contributions can reduce public opposition to pollution taxes only if subsidies are present**
    - Higher pollution taxes allow "young" to benefit from higher subsidies for their contributions

4. **Without voluntary contributions, environmental quality is higher in the long run**
    - Though contributions directly improve env. quality and indirectly reduce pollution, reduced support for government abatement plays a dominant role

Model Setup: Individuals

- Discrete time, $t \in \{0, 1, \dots\}$
- A unit mass of identical individuals is born every t
- Individuals live for 2 periods, young and old
- When young, an individual born at t faces

$$c_t^y + s_t + (1 - \theta_t) m_t = w_t$$

  - m_t: her contribution to environmental protection
  - $\theta_t \in [0, 1)$: subsidy rate
- When old, she consumes the proceeds of her savings,

$$c_{t+1}^o = R_{t+1} s_t$$

Individuals (cont'd)

- Preferences of individuals are represented by

$$u(c_t^y, E_t) + \beta v(m_t) + \delta u(c_{t+1}^o, E_{t+1})$$

  - δ: degree of patience
  - β: degree of 'warm glow' (Andreoni 1990)
  - E_t: environmental quality in period t
- Environmental quality is a public good
- For given (E_t, E_{t+1}), individuals behave such that

$$\beta v'(m_t) = (1 - \theta_t) u_1'(c_t^y, E_t)$$

$$u_1'(c_t^y, E_t) = \delta R_{t+1} u_1'(c_{t+1}^o, E_{t+1})$$

Environmental Quality

- Environment deteriorates as a by-product of production
- Environmental quality evolves according to

$$E_{t+1} = (1 - b)E_t - \gamma_y Y_t + \gamma_m m_t + \gamma_g g_t$$

  - Y_t: production level of the economy
  - $g_t \geq 0$: government abatement
- It is realistic to assume $\gamma_g > \gamma_m$

Firms

- Neoclassical production function, $Y_t = F(K_t, L_t)$
- Capital depreciates fully in one period
- Firms choose K_t and L_t to maximize

$$\pi_t = (1 - \tau_t) Y_t - R_t K_t - w_t L_t$$

  - $\tau_t \in [0, 1)$: pollution tax
- Normalization + inelastic labor supply $\Rightarrow L_t = 1$
- Perfectly competitive markets:

$$R_t = (1 - \tau_t) f'(k_t),$$

$$w_t = (1 - \tau_t)[f(k_t) - k_t f'(k_t)]$$

Environmental Policy

- A balanced-budget environmental policy,

$$g_t + \theta_t m_t = \tau_t Y_t = \tau_t f(k_t)$$

- Denote by σ_t the share of tax revenues allocated to g_t, i.e.,

$$\sigma_t = \frac{g_t}{\tau_t f(k_t)}, \; 1 - \sigma_t = \frac{\theta_t m_t}{\tau_t f(k_t)}$$

- Pair (τ_t, σ_t) characterizes all feasible combinations of the environmental policy measures g_t, θ_t and τ_t

Equilibrium for a Given Policy

Definition 1

For a given sequence of environmental policy $\{\tau_t, \sigma_t\}_{t=0}^{\infty}$ and a given initial state of the economy (k_0, E_0), an equilibrium (path) is a sequence $\{m_t, c_t^y, c_t^o, k_{t+1}, E_{t+1}\}_{t=0}^{\infty}$ such that for every period $t \geq 0$:

1. individuals solve their utility maximization problem,
2. firms solve their profit maximization problem,
3. all markets clear,
4. the law of motion for environmental quality is given by

$$E_{t+1} = (1 - b)E_t + (\gamma_g \sigma_t \tau_t - \gamma_y) f(k_t) + \gamma_m m_t.$$

Short-Lived Government

- One-period lived government that chooses (τ_t, σ_t)
- It cares only about individuals alive in period t:

$$u(c_t^y, E_t) + \beta v(m_t) + \delta u(c_{t+1}^o, E_{t+1}) + \eta u(c_t^o, E_t)$$

- Policy (τ_t, σ_t) maximizes this s.t. the equilibrium conditions
- Time-t government correctly anticipates τ_{t+1} but takes it as given
- Chosen (τ_t, σ_t) depends in general on τ_{t+1}, k_t, and E_t

Solving the Model

- We restrict attention to

$$u(c, E) = \ln c + \lambda \ln E, \;\; v(m) = \ln m, \;\; f(k) = k^{\alpha}$$

- The equilibrium (for a given policy) is characterized by

$$c_t^o = (1 - \tau_t)\alpha k_t^{\alpha},$$

$$k_{t+1} = \frac{\delta(1 - \tau_t)(1 - \alpha)}{1 + \beta + \delta} k_t^{\alpha} = \delta c_t^y,$$

$$E_{t+1} = (1 - b)E_t + (\gamma_g \sigma_t \tau_t - \gamma_y) k_t^{\alpha} + \gamma_m m_t,$$

with

$$m_t = \left[\frac{\beta(1 - \tau_t)(1 - \alpha)}{1 + \beta + \delta} + (1 - \sigma_t)\tau_t \right] k_t^{\alpha}$$

Chosen Policy

Focus on situations where government abatement is present; let us denote

$$\bar{\eta} \equiv \frac{\delta\gamma_g}{\gamma_g - \gamma_m}\left[1 + \frac{\alpha(1+\beta+\delta\alpha)}{\delta(1-\alpha)}\right] + \frac{\gamma_m(1+\delta\alpha)}{\gamma_g - \gamma_m}$$

Proposition 1

The environmental policy (τ_t, σ_t) satisfying $\tau_t > 0$ and $\sigma_t > 0$ can be chosen by the time-t government only if $\gamma_g > \gamma_m$ holds. ***(a)*** *If $\eta \geq \bar{\eta}$, this policy is given by*

$$\sigma_t = 1,\ \tau_t = 1 - \frac{(1+\beta+\delta\alpha+\eta)[(1-b)\frac{E_t}{k_t^\alpha} + \gamma_g - \gamma_y]}{[\gamma_g - \frac{\gamma_m\beta(1-\alpha)}{1+\beta+\delta}][1+\beta+\delta(\alpha+\lambda)+\eta]}.$$

Chosen Policy (cont'd)

Proposition 1 (cont'd)

(b) *If $\eta < \bar{\eta}$, this policy is given by*

$$\sigma_t = 1 - \frac{\beta(1-\tau_t)(\bar{\eta}-\eta)(1-\alpha)}{\tau_t(1+\beta+\delta)(1+\delta\alpha+\eta)},$$

$$\tau_t = 1 - \frac{(1+\beta+\delta)(1+\delta\alpha+\eta)[(1-b)\frac{E_t}{k_t^\alpha} + \gamma_g - \gamma_y]}{\gamma_g(1+\beta\alpha+\delta)[1+\beta+\delta(\alpha+\lambda)+\eta]}.$$

Both τ_t and σ_t are high when environmental quality E_t is low and/or national income $Y_t = k_t^\alpha$ is high

Steady State

Proposition 2

The capital stock k_t and the environmental quality E_t monotonically converge to their steady-state values $k^* > 0$ and $E^* > 0$, respectively, if and only if $\gamma_g > \gamma_y$ holds. These steady-state values are given by

$$k^* = \left[\frac{\delta(1-\alpha)(\gamma_g - \gamma_y)\xi(\eta)}{1+\beta+\delta(\alpha+\lambda b)+\eta} \right]^{\frac{1}{1-\alpha}},$$

$$E^* = \frac{\delta\lambda(\gamma_g - \gamma_y)(k^*)^\alpha}{1+\beta+\delta(\alpha+\lambda b)+\eta},$$

where

$$\xi(\eta) \equiv \begin{cases} \frac{1+\delta\alpha+\eta}{\gamma_g(1+\beta\alpha+\delta)} & \text{if } \eta < \bar{\eta}, \\ \frac{1+\beta+\delta\alpha+\eta}{\gamma_g(1+\beta+\delta)-\gamma_m\beta(1-\alpha)} & \text{if } \eta \geq \bar{\eta}. \end{cases}$$

Policy Effects of Voluntary Contributions (β)

- Denote by (τ^*, σ^*) the steady-state environmental policy,

$$\tau^* = 1 - \frac{(1+\beta+\delta)(\gamma_g - \gamma_y)\xi(\eta)}{1+\beta+\delta(\alpha+\lambda b)+\eta},$$

$$\sigma^* = 1 - \max\left\{0, \frac{\beta(1-\tau^*)(\bar{\eta}-\eta)(1-\alpha)}{\tau^*(1+\beta+\delta)(1+\delta\alpha+\eta)}\right\}$$

- The presence of unsubsidized contributions reduces τ^*
- The presence of subsidized contributions can increase τ^*
  - This occurs if η is not too high
- The presence of subsidized/unsubsidized contributions reduces government abatement, $g^* \equiv \sigma^*\tau^*(k^*)^\alpha$

  $\Rightarrow$ This leads to a lower E^*

Conclusion

- Interplay between voluntary contributions and environmental policy
- A dynamic general equilibrium model with overlapping generations
- Environmental policy reflects public support
- Voluntary contributions reduce government abatement expenditures
  - $\Rightarrow$ This reduces environmental quality in the long run
- Future work can deal with:
  - Intragenerational heterogeneity, long-lived government, etc.