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

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Motivation

- Recent OECD household survey reveals:
  - 11% regularly use a hybrid electric car
  - 18% have installed solar panels for electricity
  - 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

How does individual pro-environmental behavior affect public support for environmental policy and environmental quality in the long run?

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

Our Approach

- A stylized model that incorporates individuals' contributions to env. protection and their support for env. policy
- Environmental quality is a public good
- Its provision is affected over time by:
  - economic development
  - voluntary contributions
  - environmental policy
- Voluntary contributions are motivated by 'warm glow'
- Policy decision is made on behalf of individuals alive

Related Literature

- Private provision of an environmental public good
  - Jouvet et al. (2000), Nyborg et al. (2006), Kotchen & Moore (2007), Dam & Heijdra (2011), Bezin (2015), Perino (2015), Daube & Ulph (2016), Wichman (2016), Ambec & De Donder (2022), Aghion et al. (2023)
- Political economy of environmental policy
  - Bovenberg & Heijdra (1998, 2002), McAusland (2003), Cremer et al. (2004, 2008), Ono (2005), Balestra & Dottori (2012), Habla & Roeder (2013), Karp & Rezai (2014), Besley & Persson (2019)

Overview of the Main Results

1. A stronger motivation for voluntary contributions leads to lower pollution taxes and a lower government pollution abatement in the long run
2. Without voluntary contributions, environmental quality is higher in the long run

Model Setup: Environmental Quality

- Discrete time, $t \in \{0, 1, \dots\}$
- Environment deteriorates as a by-product of production
- Environmental quality evolves according to

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

  - Y_t: production level of the economy
  - m_t: abatement carried out by individuals
  - g_t: abatement carried out by the government
- It is realistic to assume $\gamma_g > \gamma_m$

Production

- Neoclassical production function, $Y_t = F(K_t, L_t)$
- Capital depreciates fully in one period
- A representative firm chooses K_t and L_t to maximize

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

  - τ_t: pollution tax rate
- Perfectly competitive markets:

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

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

Individuals

- A unit mass of identical individuals is born every t
- Individuals live for one period
- Preferences of an individual born at t are represented by

$$U(c_t, x_t, m_t, E_{t+1})$$

- Environmental quality is a public good
  $\Rightarrow$ Each individual of generation t takes E_{t+1} as given
- The first- and second-period budget constraints are

$$c_t + x_t + (1 - \theta_t)m_t = w_t + R_t x_{t-1}$$

Environmental Policy

- A balanced-budget environmental policy,

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

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

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

- 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 $\{c_t, m_t, k_{t+1}, E_{t+1}\}_{t=0}^{\infty}$ 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

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

Short-Lived Government

- One-period lived government that chooses (τ_t, σ_t)
- It cares only about individuals alive in period t
- Policy (τ_t, σ_t) maximizes $U(c_t, x_t, m_t, E_{t+1})$ subject to the equilibrium conditions
  - $\Rightarrow$ Government internalizes the effect of m_t on E_{t+1}
- Chosen (τ_t, σ_t) depends on k_t, and E_t

Solving the Model

- We restrict attention to $f(k) = k^{\alpha}$ and

$$U(c, x, m, E) = \ln c + \delta \ln x + \beta \ln m + \lambda \ln E$$

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

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

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

with

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

Chosen Policy

Focus on an interior solution for (τ_t, σ_t)

Proposition 1

The interior solution for the time-t government's problem is given by

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

$$\sigma_t = 1 - \frac{\beta\gamma_m(1-\tau_t\gamma_y)}{\tau_t\gamma_y(\gamma_g-\gamma_m)(1+\delta+\beta)}.$$

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

Suppose that $\Phi(E_t)$ is linear: $\Phi(E_t) = b\bar{E} + (1-b)E_t$

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 $\gamma_g \geq \gamma_y$ holds. These steady-state values are determined by

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

$$E^* = \frac{\lambda[b\bar{E} + (\gamma_g - \gamma_y)(k^*)^\alpha]}{1+\delta+\beta+\lambda b}.$$

Long-Run Effects of Voluntary Contributions (β)

- Contributions divert resources from capital formation
  $\Rightarrow$ Direct negative effect on k^*
- Contributions reduce the pollution tax
  $\Rightarrow$ Indirect positive effect on k^*
- The first effect dominates, so that $\partial k^*/\partial\beta < 0$

Long-Run Effects of Voluntary Contributions (cont'd)

- Contributions improve environmental quality
  $\Rightarrow$ Direct positive effect on E^*
- Contributions reduce pollution in the long run
  $\Rightarrow$ Indirect positive effect on E^*
- Contributions reduce government abatement in the long run
  $\Rightarrow$ Indirect negative effect on E^*
- The last effect dominates, so that $\partial E^*/\partial \beta < 0$

Conclusion

- Interplay between voluntary contributions and environmental policy
- A simple dynamic general-equilibrium model
- 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:
  - Two-sector economy, long-lived government, etc.