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
  - 21% often or always buy organic products
- Yet, the dominant role in environmental protection is still played by governments
- Many households are willing to compromise lifestyle for env. protection but not to pay for government-led env. protection

Research Question

How does individual pro-environmental behavior influence environmental policy and environmental quality in the long run?

Answer can provide insights into whether advocating for personal actions to fight climate change is worthwhile

Our Approach

- A simple OLG model that incorporates individuals' contributions to env. quality and public 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 decisions are made in the interests of all individuals currently alive

Overview of the Main Results

1. A higher proportion of individuals making voluntary contributions leads to lower pollution taxes and lower government abatement expenditures

2. A higher proportion of individuals making voluntary contributions leads to a lower capital stock and a lower environmental quality in the long run

Model Setup

Similar to John & Pecchenino (EJ, 1994)

- A unit mass of individuals is born every $t \in \{0, 1, \dots\}$
- Each individual lives for two periods: young and old
- Two types of individuals: passive green and active green
- Preferences of type-p individuals born at t are represented by

$$u(c_t^p, E_t) + \delta u(d_{t+1}^p, E_{t+1})$$

- Their first- and second-period budget constraints are

$$c_t^p + s_t^p = w_t$$

$$d_{t+1}^p = R_{t+1} s_t^p$$

Individuals

- Preferences of type-a individuals born at t are represented by

$$u(c_t^a, E_t) + \alpha v(m_t^a) + \delta u(d_{t+1}^a, E_{t+1})$$

- Their first- and second-period budget constraints are

$$c_t^a + s_t^a + m_t^a = w_t$$

$$d_{t+1}^a = R_{t+1} s_t^a$$

- All individuals take $(w_t, E_t, R_{t+1}, E_{t+1})$ as given, correctly anticipating (R_{t+1}, E_{t+1}) when young
- Let q be the proportion of type-a individuals in each cohort

Environmental Quality

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

$$E_{t+1} = b\bar{E} + (1-b)E_t - \beta Y_t + \gamma(m_t + g_t)$$

  - Y_t: production level of the economy
  - $m_t = qm_t^a$: abatement carried out by individuals
  - g_t: abatement carried out by the government
- Environmental protection is efficient, i.e., $\gamma > \beta$

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

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

  - τ_t: pollution tax rate
- Perfectly competitive markets:

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

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

Equilibrium for a Given Policy

A balanced-budget environmental policy, $g_t = \tau_t \beta Y_t = \tau_t \beta f(k_t)$

Definition 1

For a given sequence of pollution taxes $\{\tau_t\}_{t=0}^{\infty}$ and a given initial state of the economy (k_0, E_0), an equilibrium (path) is a sequence $\{m_t^a, c_t^a, c_t^p, d_t^a, d_t^p, k_{t+1}, E_{t+1}\}_{t=0}^{\infty}$ 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

$$E_{t+1} = b\bar{E} + (1-b)E_t - \beta f(k_t) + \gamma[\tau_t \beta f(k_t) + q m_t^a].$$

Short-Lived Government

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

$$q[u(d_t^a, E_t) + u(c_t^a, E_t) + \delta u(d_{t+1}^a, E_{t+1})]$$
$$+ (1-q)[u(d_t^p, E_t) + u(c_t^p, E_t) + \delta u(d_{t+1}^p, E_{t+1})]$$

- The tax τ_t maximizes this utilitarian social welfare function subject to the equilibrium conditions
  $\Rightarrow$ Government internalizes the effect of m_t^a on E_{t+1}
- Time-t government correctly anticipates τ_{t+1} but takes it as given
- Chosen τ_t depends in general on τ_{t+1}, k_t, and E_t

Solving the Model

- We restrict attention to

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

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

$$k_{t+1} = \left[\frac{\delta q}{1 + \alpha + \delta} + \frac{\delta(1-q)}{1+\delta} \right] (1 - \tau_t \beta)(1-\nu) k_t^{\nu}$$

and

$$E_{t+1} = b\bar{E} + (1-b)E_t - \beta k_t^{\nu} + \gamma \left[\tau_t \beta + \frac{q\alpha(1-\nu)(1-\tau_t\beta)}{1+\alpha+\delta} \right] k_t^{\nu}$$

Laissez Faire

Proposition 1

In the absence of public environmental policy, the capital stock k_t and the environmental quality E_t converge to their steady-state values k^{LF} and E^{LF}, respectively, These steady-state values are given by

$$k^{LF} = \left\{ \frac{\delta(1-\nu)[1+\delta+\alpha(1-q)]}{(1+\alpha+\delta)(1+\delta)} \right\}^{\frac{1}{1-\nu}},$$

$$E^{LF} = \bar{E} + \frac{1}{b}\left[\frac{\gamma q \alpha (1-\nu)}{1+\alpha+\delta} - \beta \right] (k^{LF})^{\nu}.$$

It follows that $\partial E^{LF}/\partial q > 0$ for all $q \in (0,1)$ if the degree of warm glow α does not exceed $(1-\nu)(1+\delta)/\nu$

Chosen Policy

Let us now focus on situations where $\tau_t > 0$

Proposition 2

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

$$\tau_t = \frac{1}{\beta} - \frac{b\bar{E} + (1-b)E_t + (\gamma - \beta)k_t^{\nu}}{\beta\gamma(1 + \frac{\delta\lambda}{2+\delta\nu})[1 - \frac{q\alpha(1-\nu)}{1+\alpha+\delta}]k_t^{\nu}}.$$

Note that τ_t is high when national income k_t^{ν} is high, while τ_t is low for a given (k_t, E_t) when the proportion of type-a individuals q is high

Steady State

Proposition 3

When public environmental policy is optimally chosen by short-lived governments, the capital stock k_t and the environmental quality E_t converge to their steady-state values k^* and E^*, respectively. These steady-state values are given by

$$k^* = \frac{\delta(1-\nu)[b\bar{E} + (\gamma - \beta)(k^*)^\nu]}{\gamma(1+\delta)(1+\frac{\delta\lambda b}{2+\delta\nu})[1+\frac{q\alpha\nu}{1+\delta+\alpha(1-q)}]},$$

$$E^* = \frac{\delta\lambda[b\bar{E} + (\gamma - \beta)(k^*)^\nu]}{2+\delta\nu+\delta\lambda b}.$$

It follows that $\partial E^*/\partial q < 0$ for all $q \in (0,1)$

Effects of Pro-Environmental Behavior, q

- An increase in the proportion of type-a individuals (i.e., q) reduces the average proportion of labor income that is saved
  - $\Rightarrow$ Negative effect on k^*
- An increase in q reduces the pollution tax for a given (k_t, E_t)
  - $\Rightarrow$ Positive effect on k^*
- The first effect dominates, so that $\partial k^*/\partial q < 0$

Effects of Pro-Environmental Behavior, q (cont'd)

- An increase in q increases private abatement for a given k_t
  $\Rightarrow$ Positive effect on E^*
- An increase in q reduces production and hence pollution in the long run
  $\Rightarrow$ Positive effect on E^*
- An increase in q reduces government abatement expenditures in the long run
  $\Rightarrow$ Negative effect on E^*
- The last effect dominates, so that $\partial E^*/\partial q < 0$

Extension: Old-Age Voluntary Contributions

- Preferences of type-a individuals born at t are represented by

$$u(c_t^a, E_t) + \alpha_y v(m_t^a) + \delta v(d_{t+1}^a, E_{t+1}) + \alpha_o v(x_{t+1}^a)$$

- Their first- and second-period budget constraints are

$$c_t^p + s_t^p + m_t^p = w_t$$

$$d_{t+1}^p + x_{t+1}^p = R_{t+1} s_t^p$$

- Private abatement at t is then given by

$$m_t = q(m_t^p + x_t^p)$$

Conclusion

- We study the interplay between voluntary contributions to environmental protection and public environmental policy
- A simple dynamic general-equilibrium model with overlapping generations
- Environmental policy reflects public support
- A higher proportion of individuals making vol. contributions leads to lower government abatement expenditures
  - $\Rightarrow$ This reduces environmental quality in the long run
- Future work can deal with:
  - Two-sector economy, long-lived government, etc.