Environmental policy and the macroeconomy under shallow-lake dynamics

Pim Heijnen (CeNDEF, University of Amsterdam)

Ben Heijdra (University of Groningen)

Honorary mention: Florian Wagener (CeNDEF, University of Amsterdam)

Standard approach in environmental economics

Tradeoff between economic prosperity and a clean environment

Unique steady state for both the economy and the environment

Local analysis

Examples in:
→ nonrenewable resource extraction (Dasgupta & Heal, 1974)
→ renewable resource extraction (Munro, 1979)
→ environmental macro (Bovenberg & Heijdra, 1998)

Recent research in ecology (Scheffer et al., 2001)

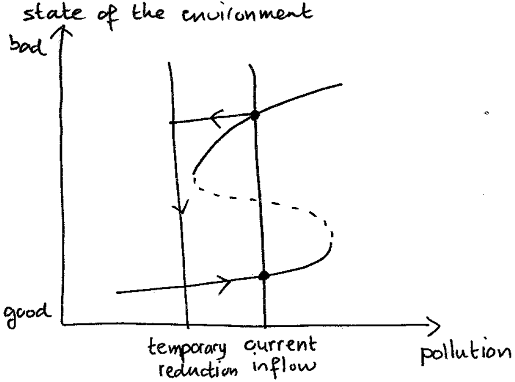
Most ecological systems have multiple steady states

Examples:
→ Shallow lakes can be turbid or clear
→ Sahara dessert/savannah

Environmental dynamics are nonlinear
→ multiple steady states and catastrophic shifts

Our approach

←



Our approach (2)

The environment is in the bad steady state

The government is 'inactive'

Temporary policy to move the environment to the good steady state

Simple (and standard) model of the economy to give an idea of:
→ the effects of the policy on the economy
→ cost-benefit analysis

The environment

P is pollution

D is inflow of pollution:

$$D = \underbrace{\kappa K}_{\text{Capital stock}} - \underbrace{\gamma G}_{\text{Govt. measures}}$$

Evolution of pollution:

$$\dot{P} = D - \pi P + \frac{P^2}{P^2 + 1}$$

The economy (base model)

Representative agent with a fixed labor supply (of one unit)

Utility (and welfare measure):

$$\int_0^{\infty} [\log C(\tau) + \epsilon_E \log(\bar{E} - P(\tau))] \mathrm{e}^{-\rho\tau} \mathrm{d}\tau$$

Agent chooses consumption to maximize utility

Competitive industry using capital and labor as inputs

The economy (base model, 2)

Using production function $Y = \Omega_0 K^{1-\epsilon_L} L^{\epsilon_L}$ and depreciation rate δ:

$$\dot{C} = [(1-\epsilon_L)\Omega_0 K^{-\epsilon_L} - \delta - \rho]C,$$
$$\dot{K} = \Omega_0 K^{1-\epsilon_L} - C - G - \delta K,$$

where $K(0)$ is given and $C(0)$ such that budget constraint holds.

Policy experiment

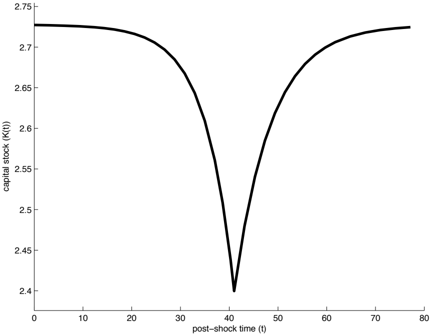
$\rightsquigarrow$

$K(0)$ and $P(0)$ such that:
$\rightarrow$ Region of multiple steady states
$\rightarrow$ Currently in the bad steady state

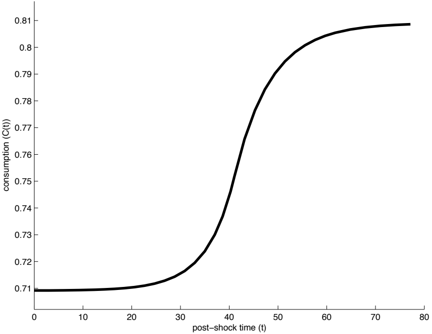
Government temporarily increases spending by g for $t \in [0, t_E]$

$g = 0.1$ and $t_E = 41$ (minimal length to force environment to clean state)

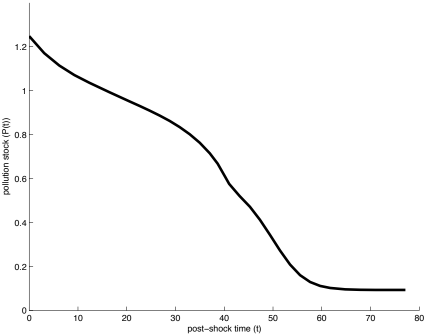
Effect of policy on capital



Effect of policy on consumption



Effect of policy on pollution



Base model: conclusions

Huge welfare effect: comparable to 26.3% extra consumption in the bad steady state

Cold turkey is slightly better: $g = 0.1166$ and $t_E = 30$ is the optimal feasible policy of this form.

Extension: endogenous labor supply

Policy less effective because of temporary increase in capital stock

If $g = 0.1$, then t_E increases by ten years.

Welfare effect down to 7.8%

Extension: finite lives

At each age a constant probability of dying, at each time a new generation of constant size is born (Blanchard-Yaari OLG)

Consequence: role for government debt

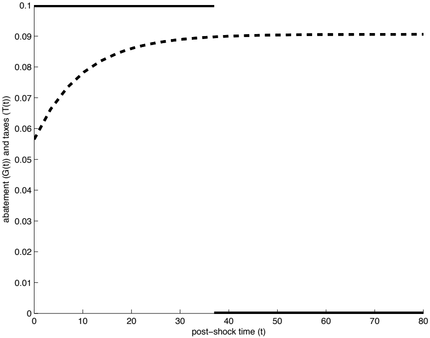
Reason: if you live forever, then you anticipate that you have to pay back debt

Two ways of financing government spending

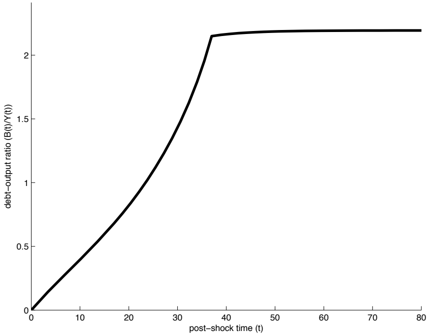
Make sure that generations that profit from a cleaner environment are paying for it.

Compare
→ No debt
→ Postpone payment

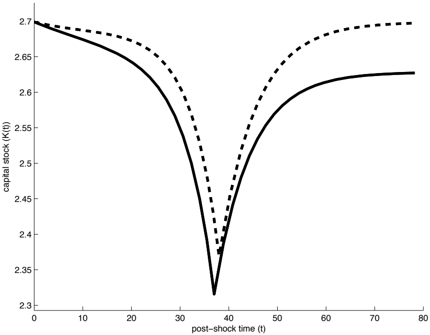
Postponing payment



Debt accumulation



Long-term effects of a temporary policy



Finite lives: conclusions

t_E decreases by three years

Long-term effects: environment becomes cleaner, consumption is less

Welfare:

	born at time of shock	steady-state newborn
no debt	10.8%	33.5%
postpone	13.5%	11.4%

The End