

Pollution, health and growth: some aspects

Thomas Seegmuller

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Environment and growth

- Climate change will be seen here as pollution. Aim of this presentation is to provide some insights on the interplay between growth, pollution and health.
- We start with some general considerations on the interplay between environment and growth.
- Economic growth: Of course an important issue largely and still analyzed by economists. "Once one starts to think about [economic growth], it is hard to think about anything else." (Lucas (1988))
- "Received growth theory is biased. It neglects to take into account the pollution costs of economic growth." (Brock (1973)) → In the last decades, extensive research has been undertaken which tries to explore the links between economic growth and the environment.

Environment and growth

- Growth and environment: a causality in both directions.
- 3 effects of growth on environment (Grossman and Krueger (1991)):
 - Scale effect: taking into account the technology, a larger production raises pollution;
 - Composition effect: specialization (or not) in non-polluting activities has a negative (positive) effect on pollution;
 - Technical effect: pollution emissions by unit of product.

Environment and growth

- Environment on growth:
 - Environment has an amenity value (affects welfare), possibly through health status;
 - Environment has a productive value (affects production), possibly through health and workers' productivity;
 - A part of economic activity may be devoted to the improvement of environmental quality;
 - Because of over-exploitation and/or irreversibilities, environment may be a limit to growth.

Environment and growth

- A link between pollution and economic development: the Environmental Kuznets Curve (EKC).

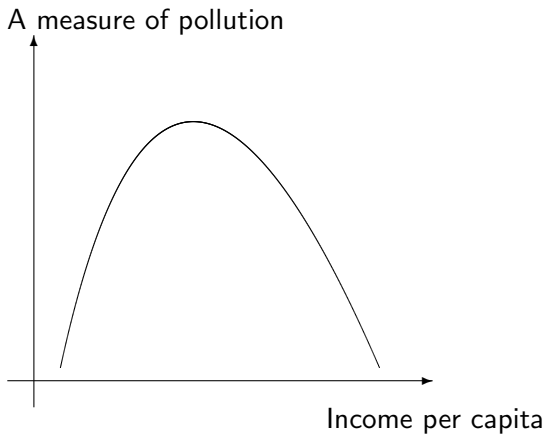


Figure : EKC

Environment and growth

- At first stages of development (industrialization), intensive utilization of natural resources and polluting technologies;
- After a peak, development uses more intensively less polluting technologies and the society is more concerned with environmental quality improvements.
- Some explanations of the EKC: the 3 effects of growth on environment (see above); the evolution of the demand (environmental consciousness, role of information, education); institutions and regulations (environmental policies, quality of institutions).

Environment and growth

- Empirical validation of the EKC:
 - Concerning water, EKC has an empirical support;
 - On solid wastes and CO₂, EKC is questioned;
 - EKC is more relevant for local pollutants than global ones, but is still questionable. → evidence for other forms of relationship (like N).
- Important notion: sustainable development: satisfies current needs without compromising future generations (Bruntland (1987)). → intergenerational equity.
- Implies a management of assets available in the economy, i.e. physical capital, human capital, pollution, natural resources.
- Optimal management means that marginal damages - costs are equal to marginal benefits. It does not imply zero pollution.

The link with health

- Pollution deteriorates health status.
- UNDP (2008), World Bank (2001), World Development Report (2010): environmental conditions considerably affect health outcomes (lack of safe sanitation, indoor pollution, exposure to disease vectors) but also through more modern environmental risks (air and water pollution, for instance).
- Poor countries are much more sensitive than industrial ones to environmental risks.

The link with health

- World Health Organization points out that outdoor pollution might be responsible worldwide for 9% of lung cancer deaths or 5% of cardiopulmonary deaths while 88 % of diarrheal deaths are attributable to unsafe water.
- Broadly speaking, climate change causes 150 000 excess deaths annually while indoor pollution kills 2 millions people in 2012.
- See among others Pope (2000), Chay and Greenstone (2003), Dasgupta (2004), Evans and Smith (2005), WHO (2004, 2006).

The link with health

- Chay and Greenstone (2003) show that a reduction in 1 mg/m³ in particulates results in 4-8 fewer infant deaths per 100 000 live births.
- They argue that chronic as well as acute episodes of pollution can translate into pulmonary and cardio-vulnerability, neuropsychiatric disorders, more hospital admissions, diseases and even deaths attributable to environmental hazards.

The link with health

- Empirical evidence shows that pollution affects health through some main channels:
 - Health is a determinant of individual welfare → pollution directly affects individual preferences;
 - Pollution affects children and elderly → pollution reduces education and longevity;
 - Health is a component of workers' productivity → pollution reduces productivity to work.
 - Additional channel: pollution alters the ability to have children → this effect on fertility implies new expenditures, affects individual welfare and may have some implications on the population size.

The link with health

- We present macroeconomic dynamic models that take into account some of the above features.
- Aim is to understand the interplay between health, pollution and growth using some stylized but understandable dynamic models.
- Underline some mechanisms through which health has a specific role. → implications for public intervention.

Motivation

- Evidence that pollution affects longevity.
- Complementarity between public health, through its effect on longevity, and economic development.
 - Larger longevity → Individuals benefit longer from their investment in the future.
 - Governments of richer countries are able to levy more resources to finance health structures.
- Literature: Chakraborty (2004), Jouvet et al. (2010), Varvarigos (2010), Palivos and Varvarigos (2012), Pautrel (2008, 2009), Balestra and Dottori (2012), Raffin and Seegmuller (2014, 2015).

Motivation

- The authorities might intervene to reduce health impacts induced by a damaged environmental quality in order to promote growth and development (Raffin and Seegmuller (2014)). Two distinct types of actions:
 - a public health policy to weaken harmful effects of pollution on health status, i.e. curative actions;
 - a public environmental policy in order to downscale environmental damages, i.e. preventive actions.
- Two main aims:
 - Study the effect of longevity, depending on pollution, on the development process.
 - Analyze the effect of the two instruments on global dynamics and long run growth.

A reduced model

- The longevity is assumed to be $\phi_t = \phi(H_t/P_t)$, where H_t represents health services and P_t a stock of pollution
- $\phi'(\cdot) \geq 0 \geq \phi''(\cdot)$ and $0 \leq \phi(0) = \delta/\epsilon \leq \phi(+\infty) = b \leq 1$.
- The law of motion of physical capital writes:

$$K_{t+1} = \frac{\phi_t}{1 + \phi_t} (1 - \tau_1 - \tau_2)(1 - \alpha)AK_t$$

A reduced model

- Law of motion of pollution:

$$P_{t+1} = (1 - m)P_t + a_1 Y_t - a_2 G_t \quad (1)$$

- $m \in (0, 1)$ is natural absorption
- a_1 captures the cleanness degree of production
- a_2 the efficiency of public abatement activities
- Two kinds of public services provided by the authorities and financed thanks to labour taxes:
 - health care services: $H_t = \tau_1 w_t L_t$
 - environmental abatement activities: $G_t = \tau_2 w_t L_t$

Dynamics

- Let us define $x_t \equiv K_t/P_t$. The dynamics of the economy reduce to $x_{t+1} = \psi(x_t)$.
- There is a trap if longevity is endogenous.

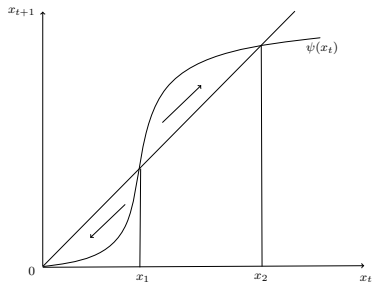


Figure : Global dynamics

- The mechanisms at stake are quite intuitive: if initially, the stock of capital over pollution is low, so does longevity and savings. Despite preventive expenditures, pollution increases more than physical capital. Consequently, life expectancy is shortened and the economy is lead into a vicious cycle.
- If the initial stock of capital over pollution is large enough, the long term stock of pollution always increases despite environmental maintenance. This result can be related to the empirical papers by Panayotou (1997), De Bruyn et al. (1998), Martinez-Zarzoso and Bengochea- Morancho (2004) or Akbostanci et al. (2009) that have pointed out the existence of a N-shaped long term relationship between economic development and pollution, in particular for the CO₂.

Environmental policy

- Two mechanisms at stake:
 - negative income effect
 - positive reduced-pollution effect

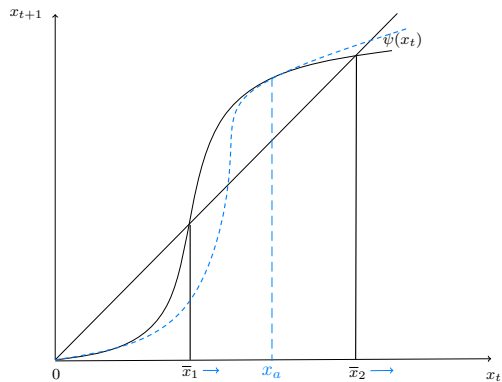
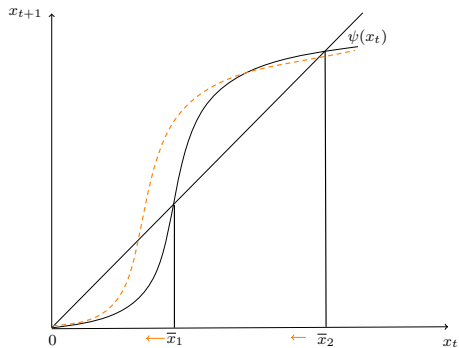


Figure : Effects of a rise in τ_2

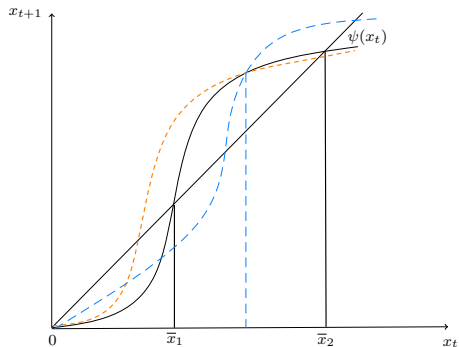
Health policy

- Two mechanisms at stake:
 - negative income effect
 - positive longevity effect



Policy Recommendations

- A rise in τ_1 diminishes the size of the environmental trap while a rise in τ_2 enlarges it.
- A rise in τ_1 lowers the high output equilibria while a rise in τ_2 increases it.
- For initial low levels of development, public authorities should invest in curative actions; once a sufficiently high level of income is reached, the public authorities should be better off by investing in preventive actions.
- Both types of public policies display a negative effect on the long run rate of growth.



Context

- The growing environmental concerns have forced several countries to adapt their tax structure by introducing new taxes on pollutants.
- One of the advantages of the environmental tax is that it provides a public revenue which can be recycled. This is the reason why it is often preferred to subsidies or emission quotas.
- But these public engagements in the environmental protection are often constrained by long-term objectives which impose to control public deficits and public debt evolution.
- Can public debt be an obstacle for the financing of environmental policies? Conversely, could the environmental tax reduce efficiently the public debt burden, and protect the environment simultaneously?

Aim

- Analyze the long-term macroeconomic impacts of environmental tax policies under a debt stabilization constraint, when public actions to protect the environment are at least partially financed by public debt (Fodha et al. (2015)).
- Consider a dynamic (overlapping generations) model with an environmental intergenerational externality.
- Pollution emissions occur through polluting production processes which deteriorate the environmental quality - health, harming the welfare of all future generations, but may be mitigated by public abatement.

Aim

- Public environmental expenditures could be financed by issuing public debt, labor income taxation or the environmental tax on production.
- Moreover, (realistic) stabilizing constraints on government budget constraint impose constant levels of government spending-output ratio and debt-output ratio.
- Environmental tax reform consists in an increase of the environmental tax rate balanced by a variation of labor income taxation, or finally debt-output ratio.
- Could such a policy be able to improve environmental quality and also economic aggregates (capital, aggregate consumption)?

Related literature

- Previous contributions have analyzed the consequences of environmental policies on environmental quality, growth and welfare (John and al. (1995), Ono (1996, 2003, 2005), Chiroleu-Assouline and Fodha (2005, 2006)), but government cannot fund pollution abatement programs by issuing public debt.
- Debt has already been introduced in dynamic models with environmental concerns (Bovenberg and Heijdra (1998), Heijdra and al. (2006)). Instead of using debt to finance a share of pollution abatement, debt policy only makes possible to redistribute welfare gains from future to existing generations.

Related literature

- Fodha and Seegmuller (2012, 2014) introduce both public debt and abatement. Instead of being concerned with a environmental tax reform, they focus on the effects of the level of public debt and abatement on capital accumulation, environmental quality and welfare (optimality).
- Our findings will explain the empirical results of Raush (2013), who highlights that when a carbon tax is employed to consolidate public debt, the environmental policies allow the possibility of sustained welfare gains for future generations.

Main results

- An increase of the environmental tax rate improves both environmental quality and aggregate consumption if public abatements are sufficiently large / efficient and there is under-accumulation of capital.
- This happens through an increase of capital accumulation and a decrease of labor taxation to balance the government budget.
- Debt plays a role, since it may ensure under-accumulation of capital.

Main results

- Distributional issues (1): Following the implementation of the environmental tax reform, aggregate consumption decreases at the first period, because the consumption of old decreases.
- However, after some date, aggregate consumption will increase on the dynamic path converging to the stable steady state.

Main results

- Distributional issues (2): At the long-run steady state, the environmental tax reform always induces an increase of consumption when young.
- Consumption when old also increases if the debt-output ratio is not too large.
- In this case, we get a double-dividend, because welfare associated to consumptions and environmental quality both increase.

Main results

- Finally, we consider an alternative environmental tax reform, by assuming that the intertemporal government budget is balanced by a modification of the debt-output ratio. The labor income tax rate is now kept constant.
- Such an environmental tax reform improves environmental quality and aggregate consumption through a decrease of the debt-output ratio.
- Indeed, capital becomes larger, because the crowding-out effect of debt lowers.
- This fiscal reform gives rise to a third dividend.

The falling sperm counts

- In the early 90s, a seminal research has been published in the British Medical Journal suggesting that human fertility has declined (Carlsen et al., 1992).
- The fertility of a couple is defined as its capacity to conceive a child during unprotected intercourse, in contrast to demographic fertility or fecundity, which refers to the number of children for a given couple.
- According to the meta-analysis of Carlsen et al. (1992) and what they call "the falling sperm counts" story, mean sperm concentration had fallen from 113 to 66 million/ml between 1938 and 1991.
- An other work conducted by Auger et al. (1995) study 1351 potential semen donors during the period 1973-1992 in Paris area. They found a convincing decline in mean sperm concentration, from 89 to 60 million/ml, or nearly 2% a year after adjustment for age and duration of abstinence.

Environmental factors as an explanation

- A still growing literature has pointed out that environmental factors could be responsible, at least partially, for the fertility decline.
- Eskenazi et al. (2010): exposure to dioxin could significantly alter fertility of couples, but also in case of intra utero exposure, the sperm concentration of the male offspring.
- Meeker et al. (2011): exposure to polychlorinated biphenyls (PCBs), in particular PCB 153, appears to harshly alter couple fertility but in addition, it turns out to lower the efficiency of medically assisted procreation and medical treatments.
- Air Pollution: more and more studies tend to warn against adverse effects of air pollution, due to concentrated industries or road traffic (diesel fumes). Selevan et al. (2000): study in Czech Republic, in highly industrialized areas, sperm quality (motility or morphology) can be significantly lower.

Aim

- All these evidences go in the direction of a raising health problem, which may be problematic for many reasons (individual welfare, lower population growth, long-run motives like debt, pensions).
- Study the dynamic path of pollution, capital and demography in presence of infertile households, the proportion of which increases with pollution.
- Since infertile households may engage in curative treatment that is successful with a particular probability, we study especially the conditions such that one converges to an equilibrium with or without health spending.

Main results and contribution

- Engaging health spending does not only depend on the marginal welfare gain of having children.
- If the pollution rate is low, one converges to a steady state without health spending. If this rate is large, one converges to a steady state with health spending.
- An important role is played by an endogenous dilution effect, which negatively affect per capita variables.
- Of course, there is a trade-off with respect to the marginal welfare gain of having children.
- In the last case, population growth is first decreasing, and after one starts health spending, may be increasing. This non-monotonic path is not at odds with what we observe for several countries around the 90's.

Main results and contribution

- Despite the individual loss and suffering of couples, economists may be interested in the socially desirable allocation.
- If the marginal welfare gain of having children is large, it is socially optimal for infertile to engage health expenditures.
- Note that there are several misallocations: capital, pollution, health expenditures, inequalities among households.

Main results and contribution

- What is the optimal policy?
- A government that want to reach this socially desirable allocation should use several policy instruments (capital taxation, health subsidy, redistribution among households).
- In particular, health expenditures will not be proportionally subsidized. It will depend on the level of health expenditures.