# ENDOGENOUS GROWTH AND SUSTAINABLE DEVELOPMENT: A CRITICAL ASSESSMENT

**P. Schembri**
*University of Versailles Saint Quentin en Y velines, C3ED, France*

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## Contents



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## Summary

This chapter is concerned with the endogenous growth literature that emerged in the 1980s and its expected new lights on the sustainable development issue. By stressing the role of investment decisions and public policy on long-run growth, this literature has enlarged research areas in this field, as well as new important findings. However, by hinging upon the optimal growth framework, the latter does not result in a renewed definition of sustainability. The latter being rooted in a utility-based criterion, still assumes input substitutability. This means that endogenous growth does not propose new insights about the critical valuation issue of environmental functions. The remainder of this chapter is organized as follows. After having sorted out the basic concepts and characteristics in modeling the interaction between endogenous growth and the notion of sustainability, we will put forward a generic model of endogenous growth including environmental quality. Then, we will survey the different payoffs and long-run growth effects linked to diverse growth equations and environmental policies. Eventually, we will discuss a few analytical limits linked to endogenous growth with regard to the sustainability issue.

## 1. Introduction

Although the notion of sustainable development already existed in the 1970s, one had to wait until 1987 and the publication of the Bruntland report for the concept to come to the top of the international and domestic policy agendas. The latter implies some intergenerational responsibilities as well as the imbedding concept of needs, which is one of the most complex issue in economics. Accordingly, it is necessary to narrow the definition of sustainable development to refer to an economy, in which future growth is not compromised by that of the present.

This chapter is concerned with the interaction of economic growth, economic policies and the natural environment, assuming that sustainable development has a multidimensional character (economic, social and ecological) which one finds in the exploration of growth-environment relationships. This observation means that sustainable development cannot be evoked without relating it to a fundamental force, being technical change, which drives economic growth in the long-run. Furthermore, sustainable development poses the problem of defining the orientation of technical change in order to achieve, in a more or less near future, a development path in accordance with biophysical regulations.

In this respect, the mid-1980s have seen the renewed interest in the growth literature stressing the role played by technical change as well as its determinants. Instead of relegating technical change entirely to an unexplained residual, the new growth literature considers it as a new production factor, whether this be called learning, Research and Development expenditures (R&D) or human capital, no longer subject to diminishing returns. The resulting so-called *endogenous* character of growth results from the assumption that the level of innovative activity induced by the accumulation of a knowledge-based capital, is now derived from economic incentives.

The long-run rate of growth thus becomes dependent of rational investment decisions, while being still affected by changes in preferences and policy. At this point, another important property of the new theory of endogenous growth that is very different from the previously prevailing one, is in its analysis of the long-run effects of public policy. The latter predicts that any policy which affects the accumulation of the technical knowledge-based capital may indeed have some substantial impacts on long-run growth. This means that public policy may make economic incentives to converge towards some target-driven growth paths. Accordingly, one could easily conceive of this recent endogenous growth literature, to shed a new light on the study of the trade-off between economic growth and the environment, as well as on the role of environmental policy to implement some so-called *win-win* or *double dividend* strategies.

The remainder of this chapter is organized as follows. Section 2 puts forward a generic model with environmental quality. Section 3 compares the different payoffs and long-run growth effects linked to diverse growth equations and environmental policies. Section 4 discusses a few analytical limits linked to endogenous growth with regard to the sustainability issue.

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## 2. Endogenous Growth and Sustainability

No doubt that the endogenous growth theory has accomplished an intellectual *tour de force* by introducing the accumulation of technical knowledge as the main source of long-run growth, while maintaining substantial rationality and intertemporal equilibrium assumptions. Also, it is not surprising that sustainable development remains defined in terms of a comparison between utility levels of different generations, with reference to the traditional prevailing theory of optimal growth. According to the latter, the link between growth and development expresses the one between the non decreasing consumption over time and the non-decreasing utility for an assumed representative infinitely lived individual, treated as a representative *dynasty*. Economic growth thus becomes a perquisite for development, the last condition for social welfare. As a general idea, sustainable development means development that takes into account both the welfare of current and future generations, while considering the opportunities for technological substitution between the different sorts of capital goods and the constraints imposed by the ecological concerns. In this perspective, sustainability includes a utility-based definition through a comprehensively defined welfare, and a technology-based one, through the critical issue of substitutability between the different so-called forms of capital, that is also called weak sustainability.

### 2.1 The Environment as a Renewable Natural Resource

Contrary to the traditional optimal growth model, the endogenous growth ones imply a more autonomous treatment of the environmental asset: sustainable development must make social welfare optimal through increasing consumption of economic goods and ecological amenities, without irreversibly diminishing environmental asset endowments over time. For any renewable environmental asset, sustainability means therefore that natural capital can be exploited and pollution emitted at rates, which cannot be more than equal to the assimilative capacity of the environment. The environment is modeled as a renewable resource, which increases through natural regeneration processes fed by ecosystems' services and solar energy inflow. This resource is treated as a specific form of capital, called natural capital, whose functions enters economic production as an input and economic consumption as an amenity. The latter appears as an indicator of environmental quality, which is a primary support for human welfare and for sustainable economic activity.

Formally, the economy's endowment in natural capital is defined with regard to the difference between a socially tolerable ecological damage, $\overline{P}$ and the observed one,

$$P : E = \overline{P} - P \quad \text{or} \quad \dot{E} = -\dot{P}$$

whether this damage results in the exhaustion of natural resources or in pollution. Moreover, a fixed fraction, μ, of this damage is assimilated by the environment. Finally, a flow of damage denotes the rate at which the natural capital is used in production and/or consumption activities. As a result, the level of ecological damage evolves over time according to Eq. (1):

$$\dot{P} = R - \mu P \qquad (1)$$

The corresponding accumulation process of natural capital results in:

$$\dot{E} = \Gamma(R, E, t) = \mu(\bar{P} - E) - R = A(E) - R \geq 0 \qquad (2)$$

The stock of natural capital has the ability to renew itself: the rate of renewal is given by the so-called assimilative capacity function $A(E)$. Both extraction of natural resources ($E$ acting as a source) and the disposal of wastes ($E$ acting as a sink) are captured by $R$, since these activities reduce the stock of available natural capital. We assume that the renewal function is bounded above – $\exists a$: $A(E) = 0$, $\forall E \geq a$ –, and beyond by supposing that $A$ may exhibit a threshold effect – $\exists h$: $A(E) = 0$, $\forall E \geq h$. This threshold effect induces an asymptotical bound on technical substitution possibilities between the economic assets and the ecological ones in the economy. This assumption acknowledges the fact that ecosystems are locally stable for given stocks of biophysical resources and become unstable when these stocks go below some critical thresholds. The presence of these stocks requires then a certain degree of complementarity with the existing magnitudes. Moreover, it limits the reversibility of investments for ecological preservation. The function is strictly concave for $E \geq h$; $A_E = \mu > 0$. It may be decreasing for $E > \bar{E}$; $\mu < 0$. This means that regeneration processes feature decreasing returns on natural capital, since the higher the stock, the more difficult the latter can be regenerated. Eventually, it is assumed that there is an absolute limit to the amount of natural capital that can be accumulated. This implies that the environment may assimilate a constant flow of ecological damage only if the latter equals the growth rate of natural capital, that is $A(E)=R$.

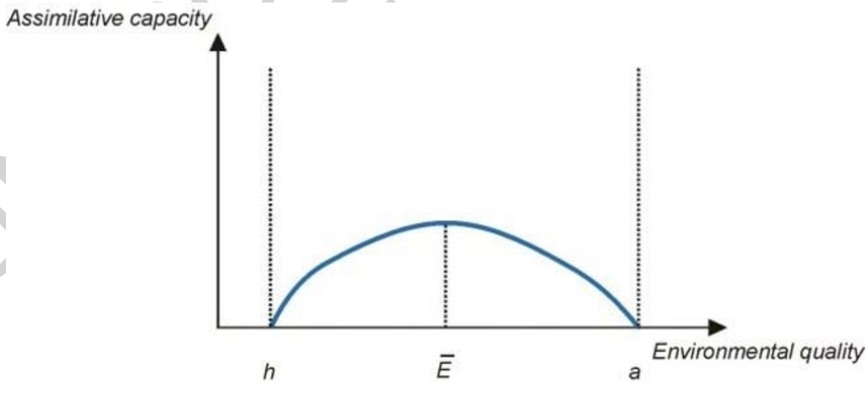


Figure 1 The Environment as a Renewable Resource

The mobile for ecological preservation leads us to focus on the alternative sources of economic growth, since investment in new technologies is not directly influenced by the evolution of the environment. This last point is very important for it underlines that the endogenous growth theory tends to preserve the criterion of weak sustainability—the one that suggests that it is theoretically possible to maintain or even raise the economic value of the environment, while the latter is exploited at a positive rate.

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**Bibliography**

Aghion P. and Howitt P. (1998). *Endogenous Growth Theory*, 694 pp. Cambridge, MA: The MIT Press. [This is a book that presents all the essential aspects of the endogenous growth theory.]

Barbier E. B. (1999). Endogenous growth and natural resource scarcity. *Environmental and Resources Economics* **14**, 51–94. [This paper applies the theory of endogenous growth to the resource scarcity principle, and tries to demonstrate that economic growth can overcome resource exhaustion.]

Benhaïm J. and Schembri P. (1995). Environnement et orientations stratégiques du changement technique. *Economie appliquée* **3**, 39–70. [An article that brings technical change and ecological sustainability concepts into reflection about environmental policy.]

Benhaïm J. and Schembri P. (1996). Technical change: an essential variable in the choice of a sustainable development trajectory. *Models of Sustainable Development* (eds. S. Faucheux, D. Pearce, and J. Proops), pp. 123–150. London, UK: Edward Elgar. [A critical assessment of the endogenous growth theory applied to environmental issues.]

Bovenberg A. L. and de Mooij R. A. (1994). *Environmental Tax Reform and Endogenous Growth*, 30 pp. Working paper, Center for Economic research, Tilburg University, The Netherlands. [A quantitative endogenous growth model with public expenditures.]

Bovenberg A. L. and Smulders S. (1995). Environmental quality and pollution-saving technological change in a two-sector endogenous growth model. *Journal of Public Economics* **57**, 369–391. [An illustration of the environment that is treated both as a public consumption good and a public capital good.]

Gastaldo S. and Ragot L. (2000). Croissance endogène et pollution: une approche fondée sur le comportement du consommateur. *Annales d'économie et de statistique* **57**, 25–48. [An analytical approach of qualitative endogenous growth that draws attention to environmental information campaigns rather than the so-called traditional instruments such as taxation and regulation.]

Gradus R. and Smulders S. (1993). The trade-off between environmental care and long-term growth: pollution in three prototype growth models. *Journal of Economics* **58**, 25–51. [This article combines the human capital theory applied to economic growth to sustainability issues.]

Grimaud A. (1999). Pollution permits and sustainable development in a Schumpeterian model. *Journal of Environmental Economics and Management* **38**, 249–266. [Another example of the endogenous growth theory applied to the resource scarcity principle.]

Grossman G. M. and Helpman E. (1991). *Innovation and Growth in the Global Economy*, 376 pp. Cambridge, MA: The MIT Press. [A now-classic book that presents the endogenous growth theory based on the expanding variety or rising quality of final consumption good.]

Hung V. T. Y. Chang P. and Blackburn K. (1993). Endogenous growth, environment and R&D. *Trade, Innovation, Environment* (ed. C. Carraro), 30 pp. Amsterdam, The Netherlands: Kluwer Academic. [A model of expanding varieties of input, assuming a form of competition between so-called dirty goods and clean ones.]

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Ligthart J. E. and Van der Ploeg F. (1999). Environmental policy, tax incidence, and the cost of public funds. *Environmental and Resources Economics* **13**, 187–207. [Another example of a quantitative endogenous growth model with public expenditures.]

Michel P. and Rotillon G. (1995). Disutility of pollution and endogeneous growth. *Environmental and Resource Economics* **6**, 279–300. [An article bringing pollution and endogenous growth issues in reflections about utility.]

Musu I. (1994). Sustainable economy and time preference. *Structural Change and Economic Dynamics* **5**, 81–86. [A learning by doing model, in which it is assumed that technical change improves the economic return of the environment.]

Musu I. (1995). *Transitional Dynamics to Optimal Sustainable Growth*. Mimeo, University Ca' Foscari and University of Udine, Venice, Italy. [Another example of the learning by doing model applied the feasibility issue of an optimal sustainable growth path.]

Musu I. and Lines M. (1993). *Endogenous Growth and Environmental Preservation*. Mimeo, University of Ca' Foscari, Venice, Italy. [A learning by doing model applied in a curative framework.]

Ragot L. (2000). Fiscalité environnementale et sensibilité écologique. *Annales d'économie et de statistique* **57**, 49–82. [A model of qualitative endogenous growth based on the expanding varieties of final consumption goods.]

Schembri P. (1997). *Le Processus de Destruction Créatrice dans les Modèles de Croissance Économique*. Unpublished Ph.D. Thesis. Economics Department, C3E, University of Panthéon–Sorbonne, Paris, France. [This analysis proposes a model of qualitative endogenous growth based on the rising quality of final consumption goods.]

Scholz C. M. and Ziemes G. (1999). Exhaustible resources, monopolistic competition, and endogenous growth. *Environmental and Resources Economics* **13**, 169–185. [Another example of the endogenous growth theory applied to the resource scarcity principle.]

Scott M. (1992). A new theory of endogenous economic growth. *Oxford Review of Economic Policy* **8**, 29–42. [An interesting paper that tries to give new analytical lights on economic growth.]

Smulders S. (1995). *Environmental Policy and Sustainable Economic Growth: An Endogenous Growth Perspective*. Mimeo, Faculty of Economics and CentER, Tilburg University, Tilburg, The Netherlands. [An interesting paper that combines some thermodynamical principles with the endogenous growth theory to study long-run effects of environmental policy.]

Van Marrewijk C. Van der Ploeg F. and Verbeek J. (1993). Is Growth Bad for the Environment? *World Bank*, July, 1151. [Another example of a quantitative endogenous growth model with public expenditures.]

Vellinga N. (1995). *Short Run Analysis of Endogenous Environmental Growth Models*. Mimeo, University of Technology, Eindhoven, The Netherlands. [A quantitative endogenous growth model with human capital.]

Verdier T. (1993). *Environmental Pollution and Endogenous Growth: a Comparison between Emission Taxes and Technological Standards*. Mimeo, 57.93, Fondation ENI Enrico Mattei, Milan, Italy. [A model of qualitative endogenous growth based on the expanding varieties of final consumption goods assuming a threshold value of the marginal productivity of labor for a specific value of the pollution rate.]

Xepapadeas A. (1993). *Long-run Growth, Environmental Pollution and Increasing Returns*. Mimeo, 67.94, Fondation ENI Enrico Mattei, Milan, Italy. [A learning by doing model applied in a curative framework that explores consequences of inserting an upper bound on pollution.]

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**Biographical Sketch**

**Patrick Schembri** is an economist. His academic qualifications are a MA in Economics and a Post Graduate Diploma in environmental economics from the University of Pantheon-Sorbonne (Paris), in which he obtained a Ph.D. (in 1997) on “Schumpeterian” economic growth models, technological innovation and sustainability. He was a visiting scholar at Brown University (Providence, MA) in autumn 1994. Lecturer in economics at University of Versailles Saint Quentin since 1999, and research fellow at the C3ED since 1995, he has been working on environmental policy, natural capital assessment, indicators for sustainable development, energy and agricultural economics, and has contributed in building the M3ED model, a multi-sectoral dynamic model, mainly used for integrated energy-economy-environment assessment and the calculation of ecologically adjusted economic aggregates.

His main publications have appeared in several books and in National and International Journals such as: *Economie Appliquée, International Review of Systems Analysis, International Journal of Sustainable Development, International Journal of Environment and Pollution*. His different fields of research allow him to participate in several national and European research programs, concerning the French agriculture and water quality; greenhouse gas abatement through fiscal policy in the European Community; the economic and social aspects of environmental issues, such as consumers lifestyles and pollutant emissions, and the application of nonmonetary procedures of economic valuation for managing a sustainable development. These different involvements led him to develop concrete relations with different European research centers, comprising the CHE at Edinburgh University, the SEO at the Free University of Amsterdam, the autonomous University of Barcelona, IVEM at Groningen University, the department of applied economics at Cambridge University, and Prague University of Economics.

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