

ANALYSIS

Redefining innovation — eco-innovation research and the contribution from ecological economics

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Abstract

While innovation processes toward sustainable development (eco-innovations) have received increasing attention during the past years, theoretical and methodological approaches to analyze these processes are poorly developed. Against this background, the term eco-innovation is introduced in this paper addressing explicitly three kinds of changes towards sustainable development: technological, social and institutional innovation. Secondly, the potential contribution of neoclassical and (co-)evolutionary approaches from environmental and innovation economics to eco-innovation research is discussed. Three peculiarities of eco-innovation are identified: the double externality problem, the regulatory push/pull effect and the increasing importance of social and institutional innovation. While the first two are widely ignored in innovation economics, the third is at the least not elaborated appropriately. The consideration of these peculiarities may help to overcome market failure by establishing a specific eco-innovation policy and to avoid a ‘technology bias’ through a broader understanding of innovation. Finally, perspectives for a specific contribution of ecological economics to eco-innovation research are drawn. It is argued that methodological pluralism as established in ecological economics would be very beneficial for eco-innovation research. A theoretical framework integrating elements from both neoclassical and evolutionary approaches should be pursued in order to consider the complexity of factors influencing innovation decisions as well as the specific role of regulatory instruments. And the experience gathered in ecological economics integrating ecological, social and economic aspects of sustainable development is highly useful for opening up innovation research to social and institutional changes. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

Since the world community committed itself in 1992 in Rio to the principles of sustainable development, it has become more and more clear that sustainability means long-term and far-reaching

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changes in technologies, infrastructure, lifestyles and institutions.

Thus, the importance of a better understanding of innovation processes has several reasons:

- The demand for drastic reductions of environmental burdens, e.g. of greenhouse gases, implies that adaptation within existing technologies is not sufficient. Instead, regulation strategies to effect ‘technology forcing’ and/or ‘technological regime shifts’ are needed.
- Secondly, innovation is expected to offset burdens and costs induced by environmental regulations. Secondary benefits of an innovation-friendly environmental policy are often seen in reduced costs, increased competitiveness, creation of new markets for environmentally desirable products and processes, corresponding employment effects, etc. Although these aspects have already been emphasized by Porter and van der Linde (1995a), the Porter hypothesis postulating ‘innovation offsets’ of strict environmental policy is not embedded in economic theory and is received with scepticism among mainstream economists (Jaffe and Palmer, 1996; Ulph, 1996).
- New types of vehicles, renewable energy systems or corresponding infrastructure often need at least a decade or more for invention, for adaptation and for diffusion, respectively. In total, it is realistic to assume time-scales of half a century and more for major changes in important economic and social sub-systems, like technological regime shifts in energy and transport systems. Thus, in situations far away from the desired equilibrium, the importance of analyzing transition and learning processes moves into the foreground.
- Moreover, many scenarios suppose that long-term sustainability goals cannot be met by progress in environmental technology and must be supplemented by corresponding lifestyles, e.g. through energy saving or changing mobility patterns, and institutional changes (ranging from local networks to global organizations).
- Inventing or adapting environmentally desirable processes or products is already part of every day life for a large majority of firms and, thus, a field of scientific research. As Cleff and

Rennings (1999a) have shown in a German industry survey, about 80% of all innovating firms are involved in environmental-friendly innovation projects. It is hard to find even a small or medium sized enterprise that has no experience at all with substituting hazardous substances, designing and using eco-efficient products, saving energy, waste and material or reducing emissions. Managing eco-innovation is an increasingly important issue for many firms.

- Finally, innumerable sustainability programs and initiatives have been set up to promote innovative policy responses and corresponding scientific research to improve the understanding of global environmental change and its relation to economic and social systems. Having this in mind, together with long time-scales, a careful valuation of experiences seems to be crucial to identify key determinants and success factors of innovation processes toward sustainability, i.e. to analyze which experiments succeeded, which failed, why they failed and in which phase.

Due to the fact that existing theoretical and methodological frameworks do not address these problems adequately, research needs can be identified to improve our understanding of innovation processes toward sustainability in their different dimensions, complex feedback mechanisms and interrelations. Such a framework should be able to give some guidelines about how to analyze the driving forces of these processes in their different characteristics and phases, to identify promising examples as well as bad ones, and to give some idea about their transferability to other contexts.

This paper intends to discuss the potential contribution of neoclassical and (co-)evolutionary approaches from environmental and innovation economics to fill this gap. A crucial question is whether innovations toward sustainability can be treated as normal innovations or if a specific theory and policy are needed. The paper is organized as follows: Section 2 redefines the term innovation considering its relation to sustainable development. Section 3 describes main economic approaches for analyzing innovation processes and environmental policy, i.e. neoclassical and

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