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Book Review:

'Time Strategies, Innovation and Environmental Policy' and edited by Christian Sartorius and Stefan Zundel (Edward Elgar Publishing, 2005).

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Abstract

The aim of this review is to provide a critical evaluation of the book entitled 'Time Strategies, Innovation and Environmental Policy' and edited by Christian Sartorius and Stefan Zundel (Edward Elgar Publishing, 2005).

The main emphasis is on the theoretical work developed in the book rather than the empirical part. Indeed twelve case studies are constituting the main part of the book and are used to test the hypothesis underlying the conceptual framework. But since each case is evaluated in the light of the main common concepts (path-dependence, lock-in, windows of opportunity) we find it more suitable to focus the review on the theoretical framework.

The book makes a significant contribution to the important issue of sustainability and transition management through the analysis of technological competition case studies involving new environmentally improved technologies.

Keywords: Innovation, Environmental Policy, Path-dependence, Windows of Opportunity

JEL: Q53; Q55; Q56

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In order to deal with environmental problems, standard environmental economics derives policy recommendations from a framework based on negative externalities and the necessity to internalise them. By focusing on the allocation of resources by markets, such analysis is static and fails to account for the creation process of resources over time - in particular technological change - but also for the context and time specific changes in economic systems that are involved by environmental pressures. The present book tries to grasp the full complexity of the management of environmental problems by adopting a dynamic approach and by developing empirical case studies that point to time-critical strategies of actors in the social, techno-economic and political spheres. Based on a theoretical framework that borrows analytical concepts from evolutionary economics (path-dependency, lock-in) and political science (Kingdon's stream model, 1995), the authors rely on the concept of 'window of opportunity' and use a large range of empirical studies to test and refine the hypothesis derived from their theoretical framework.

The main goal of the book is to understand why and how the diffusion of environmental benign innovations has been stimulated or inhibited by taking into account time-critical events and sequence of interactions among different streams or systems that had or have to cope with environmental problems. A conceptual framework is proposed as well as tested and illustrated with twelve case studies. Such analysis is therefore meant to 'provide policy-makers with a theory-based, albeit readily operable, tool for the determination and strategic use of windows of opportunity for the implementation of sustainable innovations' (cf. p.5).

Since innovations are essentially a dynamic phenomenon, they put into question the dynamic efficiency of economic instruments (pigovian tax, Coasian solutions of private property rights) to deal with the trade-off between economic and ecological sustainability. Several arguments are underlined by the authors. First, the increase in efficiency brought about by many innovations could relax the tension between the economy and ecology and thus render tax and emission-trading schemes obsolete. Second, every new or improved technology is likely to cause its own side effects and thus cause more profound difficulties in the longer run. Third, in order to be translated into an appropriate policy measure, an environmental problem first needs to be perceived as a problem and to attract attention and public concern. Fourth, path-dependence and lock-in effects matter when considering the competition of most fundamental innovations with their established technological counterpart. So, according to the authors, these innovation-related characteristics call for a dynamic approach of ecological innovation policy.

Such dynamics is based on the ability of a society to solve problems while being able to keep pace with the generation of new problems by the current technological development. The authors thus emphasise that one main difficulty is the rigidity of the established technological development once the search for ecological sustainability suggests the technological path should take another direction. In order to maintain sustainability over longer periods of time, sustainability should therefore be thought of as the general capability of redirecting a technological development and adapting to changing circumstances. In fact, the perspective adopted by the authors lead them to redefine what sustainability is and to provide original foundation to government activity whose task would be to maintain a permanent balance between the ability to solve problems and the generation of new problems by both established and new technologies.

In a first step, the authors focus on the dynamics of techno-economic systems in which innovations occur. Here concepts from evolutionary economics are necessary to specify some features of innovation that are also particularly relevant for environmental questions. First, the change from one paradigm to another underlies a problem of transition that turns to be of particular importance when considering the shift towards new more sustainable techno-economic systems (transport, energy, agriculture etc.). Second, path-dependency plays a major role in generating inertia and self-reinforcement in existing technological trajectories, that can result in a lock-in, i.e. the temporary dominance of an inferior technology. In this context, not only small events can have major effects on the technological development but also cumulative processes may lead to the persistence or emergence of suboptimal technologies and thus inhibits the transition towards another. Third, periods of stability are temporary and alternate with phases of turbulence where the transition to an alternative technological path is more easily accomplished, giving rise to windows of opportunity, i.e. the temporary existence of circumstances that allow novelty to get selected. Using a window of opportunity, innovative 'entrepreneurs' have a better chance of influencing the long-term direction of technological, economic or social development than during periods of stability outside the windows.

Two kinds of technological competition (old versus new and new versus new) are distinguished by the authors according to the ability of competing technologies to meet similar functions or rather different functions meeting different demands. Since the solution of an environmental problem generally defines a new function that matches the corresponding demand (set for

example by a new regulation), several technologies executing this function happen to compete with each other on the level 'new versus new'. But the new environmentally improved technologies have also to fulfil the genuine function of the established technology they are supposed to replace and this gives rise to a competition 'old versus new'. Depending on the case, the circumstances behind the opening of windows of opportunity are different. In the first case (new versus new) the window is open in the early stage of competition between technologies developed for corresponding purposes. Increasing returns to adoption are typical determinants of this kind of window. In the second case (old versus new) the window typically tends to open if the investment cycle of an old technology comes to an end and new promising technologies are available at that time. However, the authors also note that the competition 'new versus new' cannot be analysed alone, but needs to be seen in close relation to the competition 'old versus new'. Indeed, the window is the result of mutual interaction between the new technologies and their established counterpart. Whatever the case, the concept of window of opportunity leads to put into light time critical events and the importance of choosing the right point in time for government action. But it also raises the dilemma between the prolonged maintenance of technological diversity on the one hand and the realisation of economies of scale and scope on the other. This is a relevant question when considering the difficult implementation of the principle of precaution.

Several stabilising and destabilising factors in the techno-economic system are listed like economies of scale, economies of scope, learning by doing, sunk cost, network externalities, market structure, risk versus potential, and demand. Not all factors are relevant in each case and in each situation. But the authors clearly put forward that many factors come into play and that it is appropriate to consider the combined effects of different factors as additive.

In a second step, the authors make clear that selection environment has to be broadened to also include political and social dimensions. Three subsystems will then be considered: the socio-cultural system, the political system and the techno-economic one. The literature on political science suggests that important factors which influence political stability and change, and hence the success and failure of technologies, are: norms and standards, actors in the dominant path as interest groups in the political process, administrative routines, budget constraint, elections and the electoral cycle, other institutional cycles, administrative or political reappointment, judiciary decisions, political scandals or crises, new international treaties and obligations. From this list of

factors, the authors put into evidence that there is a broad range of driving forces for describing the blocking or the fuelling of policy changes. Again not every driving force is of equal importance in each situation.

Based on this set of concepts and factors, the core of the theoretical framework consists in examining the interplay between different subsystems, each evolving over time. Such analysis is meant to emphasise a sequence of periods of change i.e. a sequence of windows of opportunity in the societal subsystems. The authors argue that a successful innovation policy for transitions or path changes requires a combination of windows and favourable conditions. Four hypotheses thus guide the empirical investigations in the case studies and are tested: 'window of opportunity' hypothesis, 'path dependency' hypothesis, 'time matters hypothesis I' (escaping lock-in and policy) and 'time matters hypothesis II' (possibility of another lock-in after the original lock-in was overcome).

The main part of the book is devoted to the reconstruction of histories of competition between established technologies and environmental friendly technologies that meet similar functions, i.e. *a priori* adapted to a specific problem-solving. The following examples are tackled: CFCs (Chlorofluorocarbons), chlor-alkali processes, catalytic converters versus lean-burn engine, photovoltaic cells, chemical pesticides versus bio-pesticides (LUBILOSA), the ZEV (Zero Emission Vehicle) mandate, stationary fuel cells, EDTA (Ethylenediaminetetraacetate) which main applications are in photo chemicals and in washing powder and cleaning detergents, combined-cycle gas turbines, iron and steel production technologies, nuclear power technologies, VHS vs. BETA in video recording. The two last cases appear a little bit less adapted to the issue of sustainability. But according to the authors, both are enlightening and enrich the hypothesis underlying the conceptual framework.

After the detailed reconstruction of technological competition cases, the various authors' contributions analyse the case studies within the theoretical framework on window of opportunity. In this framework, many factors affecting technological competition and the effects of policy are addressed, most of which prove more or less relevant in the different case studies. However, some factors seem to prove to be highly important in all cases, like for example sunk costs and learning by doing in the techno-economic sphere and actors in the dominant path as interest groups in the political sphere. A clear invalidation or confirmation of the systematic

significance of few factors among the ones listed in the theoretical framework would have been appropriate in the last overview chapter. In this chapter, the main lessons are drawn from the confrontation between the theoretical analysis and the empirical examples developed throughout the book. The first important result holds that the success of an environmental innovation policy strongly depends on the interplay of stable and unstable periods in the three systems (techno-economic, political and socio-cultural). The three systems are interrelated and here time aspects are often ill-considered in the sense that policy may act too quickly, too late or in a too prescriptive manner, disregarding more long term solutions. Thus, time really matters and dynamic processes seem to be very important for environmental policy. The second important result holds that a successful transition strategy strongly depends on the kind of competition (old-versus-new or new-versus-new), the status of the techno-economic system (stable or unstable) and the quality of alternative technological trajectories (degree of competitiveness of alternative solutions) which are all time variant. A taxonomy summarises such result and proposes what should be the related policy objectives according to the various situations. We can nevertheless wonder whether the different dimensions considered in the taxonomy are really discriminating. In particular the kind of competition appears not to be an applicable dimension in four over seven case studies. It follows that the separation between 'time matter hypothesis I' and 'time matter hypothesis II' seems not very suitable. But this issue is not discussed by the authors.

It remains that the categorisation of situations and political strategies which is proposed by the authors enables to emphasise some main implications: in a dynamic context, the 'technological content' of economic instruments such as taxes or tradable permits depends on the time of implementation. If a given techno-economic system is in a stable phase, these instruments mainly induce an improvement of dominant technologies; if the system is unstable, even a weak use of these instruments may change the direction of the system's development. Thus, corroborating a previous result from Nill (2004), the dosage, design and timing of instruments proves to be much more important than usually assumed in economic textbooks. Finally, the examples covered throughout the book illustrate that many starting points for change exist, like for example public demand, scientific discovery, anti-trust policy, the need to modernise a sector etc. But the case studies also demonstrate that the success conditions depend in a complex manner on the political time strategy used.

The authors also analyse the different types of time strategies for policy intervention. Here the authors make a useful distinction between window preparation, window creation (or technology-

forcing) and window utilisation. In all types of time strategies, the appropriate co-ordination of windows of opportunity in the techno-economic, the political and the social subsystem proved crucial in stimulating the development of environmentally friendly technologies. In the last chapter, the authors list a number of implications for policy makers aiming at putting political time strategies in place.

The book is worthwhile reading for anyone interested in the history of technological competition that involves new environmentally improved technologies, as well as for students of environmental economics or innovation studies in general. The study provides accurate case studies of environmental problems and technology solutions, their success and failure. What is more, covering 12 case studies - which two are not directly concerned with sustainability issues -, the authors have succeeded in accounting for the coevolution of environmental innovations and regulation through time via public pressure and scientific controversies. Analysed through a technological competition focus, the general issues of transition management are addressed, which are of particular relevance to many problems of sustainability. These issues concern: i) the importance of a systemic perspective to account for the interplay between different subsystems, ii) the variety of possible schemes and sequence of windows of opportunity in the societal subsystems, iii) the importance of time and history in the success or failure of environmental innovation policy and iv) the influential interplay between short term policy actions and long term planning but also between global and local environmental regulations that affect the international diffusion of environmental technologies and give rise to competitive (dis)advantage to firms and countries.