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# Lead Markets for Environmental Innovations


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With 52 Figures
and 20 Tables

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# Preface

Some countries are earlier than others in the development and introduction of environmental innovations. If other countries follow their examples and adopt their innovation design as well, these countries can be analysed as lead markets. In this book, contributions from innovation economics, environmental economics, and policy sciences are reviewed to explain the leadership of such countries. In case studies on environmental innovations such as photovoltaic cells, fuel cells, chlorine-free paper bleaching, diesel particulate filters, social responsible investments and others the lead markets are identified and factors that determine their advance are analysed. Often, the leadership in technological development is accompanied by a leadership in environmental policy. There is a parallel diffusion of environmental technologies and policies. Based on the theoretical considerations and the case studies, policy recommendations for R&D policies, environmental and industrial policies are derived to support the development of lead markets for environmental innovations.

This book is the result of a joint research project under the title "Policy Framework for the Development of International Markets for Innovations of a Sustainable Economy – from Pilot Markets to Lead Markets (LEAD)". The authors are grateful for the funding provided by the German Federal Ministry of Research and Education (grant number 07RIW1A).

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# 1 Introduction

## 1.1 The Notion of Lead Markets

There are considerable differences in the rate of adaptation of environmental innovations among the different countries. Some countries are earlier in adopting innovation, and the penetration of markets is more encompassing than in others. If these innovations are adopted subsequently without great changes in other countries, the countries where the first market introduction took place, can be viewed as *lead markets*. The concept of lead markets has been developed and fruitfully applied for any type of technological innovations. Examples for lead markets for non-environmental innovations are the mobile phones that were introduced in Finland, the fax in Japan or the internet in the USA (Beise, 2001). The lead market is not necessarily the country where the technology was actually invented. These markets have the characteristic that product or process innovations that are designed to meet local demand preferences and conditions can be introduced in other geographic markets as well and successfully commercialised without many modifications. A lead market is the core of the world market where local users are early adopters of an innovation on international scale (Beise, 1999). This definition focuses on two characteristics of lead markets. Firstly, they are pioneering countries in the development and – more important – the marketing of innovations. Secondly, innovations that arise in these markets subsequently diffuse worldwide. Both phenomena call for analysis and explanation.

At first glance, lead markets are countries with the following features (Meyer-Krahmer, 1999):

- High per capita income,
- Demanding, innovative buyers and high quality standards,
- Problems creating pressure for change and innovation,
- Flexible regulation and innovation-friendly basic conditions for producers and users,
- Product standards acknowledged in other countries.

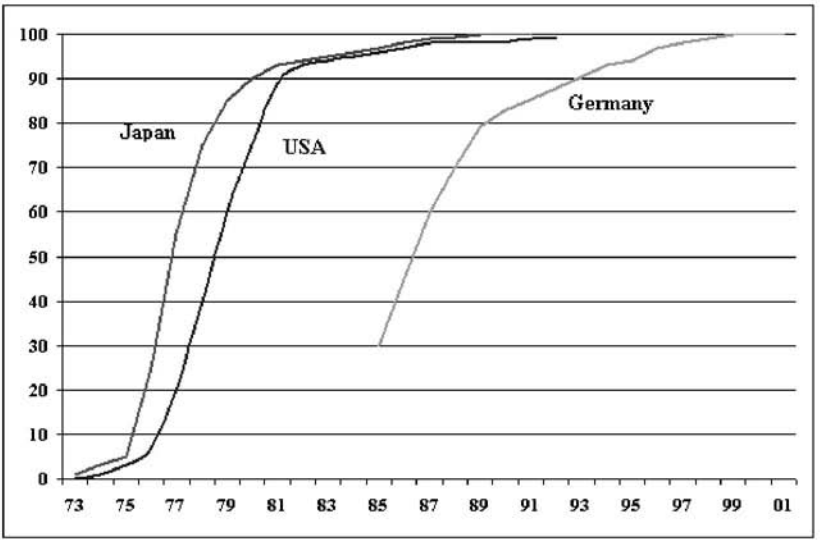
These factors hint to the fact that there are many different economic and policy factors that contribute to the emergence of such markets. Our study systematises the different factors that can be found in different streams of literature. Our approach is largely explorative, since no encompassing explanation has been developed for the emergence of lead markets for environmental innovations so far. Based on this study we develop recommendations for policy strategies that are able to stimulate the emergence of lead markets.

Our studies are dealing with lead markets for environmental innovations. It can be expected that the above mentioned factors are characteristic of lead markets for *environmental* technologies as well, but that there are also additional factors at work here, arising from the particular context in which environmental innovations are developed, both at the national and international level.

The history of environmental protection is rich in examples for lead markets: It encompasses the legally enforced introduction of catalytic converters for automobiles in the United States, desulphurization technologies in Japan, the Danish support for wind energy or the CFC free refrigerator in Germany. Another impressive example is the global diffusion of chlorine-free paper, from the political activities by Greenpeace and the EPA in the United States, by way of the introduction of chlorine-free paper whitener in Scandinavian countries and various Greenpeace campaigns in Germany and Austria, right through to effective political market intervention in Southeast Asian countries like Thailand (Mol and Sonnenfeld, 2000, see chapter 4.4 for a more detailed analysis). The latter case shows that political action that stimulates internationally successful innovations is not limited to governmental agencies only, but that this function at least regarding the process of setting environmental objectives may also be taken over by environmentalists.

Lead markets can be represented by the rate of market penetration in the different countries. The diffusion starts earlier and the market penetration is typically more complete than in other countries. An example is the catalytic converter for cars (see for more detailed discussion: chapter 4.5):

**Fig. 1.** Share of passenger cars equipped with catalytic converter in %




California became the pacesetter for air quality and automobile emission standards from the 1960s on. U.S. congress took over these far-reaching standards in

1970 that were not to be met with existing technologies. That was for the first time a purposeful technology forcing. However, the short period of time to meet the standards did not allow the development of a new engine design. Therefore, the catalytic converter became the dominant technical strategy to reduce emissions. The U.S. regulations were adopted by several countries with automobile industry. In particular Japan adopted early the US regulations, in order to adapt its own car industry to global markets and to enhance its competitiveness.

While the U.S. standards were postponed and lowered due to successful lobbying of the U.S. car industry, the Japanese government maintained the earlier objectives. In Europe, the regulations favouring a catalytic converter had been adopted in 1985, and among the European countries Germany took over the leading role, mainly due to its export oriented automobile industry.

What are the determinants that cause the differences in the introduction of innovations? What are the characteristics of the leading countries? Is there room for manoeuvre for a purposeful establishment of lead markets for environmental innovations?

From our case studies as well as previous studies we can infer that technical *environmental* innovations have to be largely ascribed to governmental (or NGO) activities. Environmental innovations are not only stimulated by the higher environmental standards of consumers in a country as compared with those in other countries, but also by special promotional measures, or by political intervention in the market (Klemmer et al., 1999; Jänicke et al., 2000). If the technologies cause additional costs without improving the benefits for the users as for the case of end of pipe measures, regulatory interventions are even indispensable for innovation and diffusion. But also in cases of integrated technologies, with additional advantages in efficiency, policy measures are often necessary to stimulate innovations and to support their diffusion. The underinvestment in environmental innovation can be explained by the double externality of R&D efforts made in environmental technologies: Alongside the spillover effects that can be observed for any R&D activities, efforts in *environmental* technologies do result in improvements of the environment which again is a public good. Therefore an underinvestment in environmental innovations can be expected (Rennings, 2000).

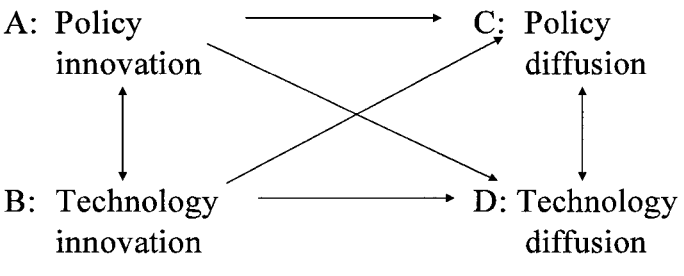
Environmental innovations do have another characteristic that is in favour of their international diffusion: They provide marketable solutions to environmental problems that are usually encountered worldwide, or at least in many countries. Thus, technological solutions to environmental problems inherently lend themselves to adoption in international or global markets.

The regional differences in adoption and diffusion of innovations cannot be explained with the specifics of environmental innovations. For this purpose, the framework conditions and political strategies in the leading countries have to be analysed. The dependence of environmental technologies on regulatory measures leads to the question to what extent national environmental policies to stimulate lead markets remain possible and effective in the context of globalisation. Our theoretical and empirical investigations, however, reveal that there is considerable room for manoeuvre for national actors. Typically, policy innovations arise in a national framework rather than being imposed by an international regime. Innova-

tive policies do diffuse very much like technological innovations. The process of diffusion is determined by the capacities of the innovating countries to develop environmental policies, by the type of innovation and the underlying problem, and by activities of international actors that often look for best practices on the national level and stimulate their diffusion (Tews et al., 2003, see chapter 2.2 for a more detailed discussion).

There is a close inter-linkage in the innovation and diffusion of environmental policies on the one hand and the innovation and diffusion of technologies on the other hand. The interplay between the diffusion of environmental policy measures and environmental technology can take a wide variety of possible sequences as depicted in the following graph.

**Fig. 2.** Stage model of the diffusion of environmental innovation




**Policy induced diffusion**

Technology forcing

(A⇒B⇒C⇒D): e.g. US-car emission standards (1970)

Political initiative (A⇒B⇒D⇒C): e.g. Cadmium substitutes

Political dominance

(A⇒C⇒B⇒D): no example yet?

**Technology induced diffusion**

Technological initiative

(B⇒A⇒C⇒D): e.g. wind energy

Technological dominance

(B⇒A⇒D⇒C): e.g. CHP technologies

Autonomous diffusion (B⇒D): e.g. Incremental improvements of energy efficiency

Source: Jänicke (2000).

Theoretically, it is possible to distinguish between the following diffusion scenarios, depending on the factors leading to the political and technological innovations:

- *Technology forcing* (A⇒B⇒C⇒D): A national environmental policy innovation in one country forces a technological innovation which diffuses if the policy innovation also diffuses (e.g.: catalytic converter technology in cars).
- *Technological initiative* (B⇒A⇒C⇒D): An existing environmental technology induces a political innovation the diffusion of which in turn encourages the diffusion of the technology (e.g.: wind energy in Denmark).
- *Political initiative* (A⇒B⇒D⇒C): A national environmental policy leads to technological innovations the diffusion of which in turn encourages diffusion of the policy innovation (e.g.: cadmium substitute).