

Lead Markets for Environmental Innovations: A New Role for the Nation State

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It is often argued that economic globalization is a strong impediment for national policy-makers in the field of environmental protection.¹ Since environmental standards tend to increase the costs of production and products, industry will move to countries with the lowest standards. This relates also to other fields of public policy that bring additional financial burdens, such as social policy or taxes. To become the most attractive location for firms, regulators are expected to compete for the lowest standards, the lowest tax rates, and so on. According to this line of arguing, economic globalization leads to a “race to the bottom” and to deregulation to attract foreign investments. This phenomenon of deregulation became known as the “Delaware effect” of globalization. (It was in Delaware where a US-wide competition on deregulation of corporate chartering began.)²

However, for environmental standards, the antagonism between economic integration and strict standard-setting does not seem as severe. Often, high standards in important export markets force producers to adapt to these standards. Due to scale effects in production, but also to obtain the image of an innovative firm, it is sensible for firms to adapt to higher standards for other markets on a voluntary basis. The example of exhaust-gas standards for cars set

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1. For an overview, see Bernauer 2000; De Vries 2001; and Wheeler 2001.
2. In the United States, charters are granted by states, but all states are required to recognize each other’s charter. In the course of this competition, the race-to-the-bottom was won by Delaware by lowering the level of protection for employees, shareholders and customers (Vogel 1995).

by California, which led to the worldwide adaptation by car manufactures, is most prominent; it became known as the “California effect.” It has been argued that this mechanism may apply only to product regulation.³ It seems, however, that there is empirical evidence for a spread of industrial pollution control standards as well.⁴

In short, the expectation of a generally diminishing role of the nation state in setting demanding environmental standards in the context of globalization has not been supported by empirical research. But why? Why does the nation state not “wither away” in environmental policy? Apparently, the open (“globalized”) national economy needs, and is indeed characterized by, strong governments, both in size and scope. According to cross-national studies, public expenditures per capita in open OECD economies are higher than in countries that are less integrated in world markets.⁵ This contradicts the argument that economic globalization weakens the nation state. Both a larger size and a larger scope of government activities in highly integrated countries can be plausibly explained by three reasons: a well-developed infrastructure is needed for successful international competition, including more public spending in fields like higher education, research and development, or transport; the distributional effects of rapid structural changes call for compensation; and more regulatory activities are needed to adapt to international developments.

The nation state remains the “local hero,” not least in the field of environmental protection. There is no functional equivalent to national governments as highly visible, legitimized and competent territorial actors and protectors.⁶ To whom else could citizen address their complaints? Governments have no exit option. Furthermore, they do not react to economic pressure alone but also to the preferences of voters. Therefore, national governments try to find at least compromises between the requirements of the economy and the environment. Often, the answer is technology. As far as technology can provide solutions for environmental problems (in many fields more far-reaching “structural” solutions are needed), there is a high potential for national policies.

The effects of globalization vary considerable between different policy domains. Wages, taxes on mobile sources and social security come under pressure for a lowering of standards because of economic globalization.⁷ Other policies, such as environmental policies, but also health or security standards, have a different logic in international regulatory competition. Several empirical cross-national studies have rejected the race-to-the-bottom hypothesis.⁸ Strict

3. Vogel 1997; and Scharpf 1999.

4. Hettige et al. 1996.

5. Cameron 1978; Garrett 1998; and Bernauer 2000.

6. Willke 1992.

7. Scharpf 1998.

8. “We find no race to the bottom . . . countries with more open trade regimes have more stringent regulations” (Eliste and Fredriksson 1998). National environmental pioneer policy can create “first-mover advantages” (Ashford and others 1979; Porter and van der Linde 1995; and Wallace 1995). Bangladesh, India, Indonesia and Thailand “are fast adopting industrial pollution control standards similar to those in developed countries” (Hettige et al. 1996).

environmental policy does not lead to the relocation of “dirty industries” into developing countries with re-imports of the products into industrialized countries.⁹ Many reasons for this are now well known.¹⁰ Countries and companies that trade with countries with strict regulations tend to have stricter policies themselves¹¹—the largest markets are rather strictly regulated. The globalization of environmental policy has partly changed the framework conditions of the world market.¹²

Regulatory competition in environmental policy often even creates first-mover advantages for national economies. Environmental technologies are becoming increasingly part of the global competition.¹³ The so-called “Porter hypothesis” argues that a strict environmental policy can improve the competitiveness of firms and sectors.¹⁴ First, a competitive advantage might be achieved in the case of a strict environmental policy that, at a later stage, diffuses internationally. If there has been a development of technologies in response to strict environmental standards, industries (not necessarily the polluting industry itself), might be able to export their technologies. Their competitive advantage may be based on learning effects or patent protection for their innovation. Secondly, strict environmental policy might lead to innovation in the polluting industry itself that compensates or even overcompensates for the costs of adaptation. This part of the Porter hypothesis has been labeled the “free-lunch” or even “paid lunch” hypothesis. Although the existence of considerable inefficiencies cannot be explained by conventional economic theory, there is broad empirical evidence supporting this hypothesis.¹⁵

The Porter hypothesis has been supported also by policy science research on pioneer countries showing evidence for economic advantages of ambitious environmental policies.¹⁶ Pioneer countries in environmental policy are highly competitive. The Global Competitive Report shows a remarkably high correlation ($R^2 = 0.89$) between ambitious environmental policy and the competitiveness of a country.¹⁷ Other studies have revealed a similar relationship between eco-efficiency and competitiveness.¹⁸ The causal relation can be in both directions. In addition, third factors (e.g. the GNP per capita) may explain the interrelation. However, the hypothesis of a contradiction between competitiveness and a demanding environmental policy can be rejected. The explanatory importance of GNP for strict environmental policy and high competitiveness may be explained by the high-perceived environmental pressure and high capacity to react in economically advanced countries.

9. Jaffe et al. 1995; and Jänicke and Weidner 1997.

10. Vogel 2001; Wheeler 2001; and Drezner 2001.

11. Eliste and Fredriksson 1998; and Foljanty-Jost 1997.

12. Jänicke and Weidner 1997; Weidner and Jänicke 2002; and Vogel 2001.

13. Porter 1990; Wallace 1995; and Faucheux 2000.

14. Porter 1990; Porter and van der Linde 1995; see also Ashford et al. 1979; and Taistra 2001.

15. See for example, Taistra 2001; Taistra 2000; Jaffe et al. 1995; and Hübner and Nill 2001.

16. Wallace 1995; Jänicke and Weidner 1997; Weidner and Jänicke 2002; and Andersen and Lieferink 1997.

17. Esty and Porter 2000.

18. Sturm et al. 2000.

Strict environmental regulations also remain a possibility to protect national industries. Multinationals tend to use the same standards everywhere.¹⁹ Differences in environmental standards tend to decrease; they are generally less important than differences for example in labor costs or taxes. Environmental protection has become a dimension of general technological progress. Forty percent of all innovations in 2010 are supposed to be relevant to environmental improvement.²⁰

To conclude this introductory analysis, the race-to-the-bottom hypothesis suffers from several highly questionable assumptions. It assumes that environmental regulations impose costs for producers that affect location, regardless of differences in labor productivity. It also assumes that governments react exclusively to the preferences of international capital, ignoring the preferences of voters or interest groups.²¹ Last but not least, the race-to-the-bottom hypothesis overestimates the importance of environmental costs and the differences in regulatory costs, as well as the general role of prices, hence ignoring the role of innovation in global competition. Recently, it has been argued also by political actors that environmental issues become more important in the competition on innovations.²²

Supporters of the race-to-the-bottom hypothesis also have different expectations for international regulation. They believe that unilateral action by nation states in the context of economic globalization is less likely regarding not only transboundary problems, but also all environmental problems with additional costs. In this view, a “regulatory chill”²³ is independent from real adverse impacts on competitiveness that far-reaching unilateral environmental regulations could bring about. Once politicians and voters are convinced that regulatory measures harm national competitiveness, those industry sectors affected by environmental policies will use this argument to make credible threats.²⁴ In this perspective, effective environmental policies depend on whether the international community will set globally binding standards and create effective international governance structures to enforce these standards—global governance will become the solution for national and local environmental problems.²⁵ Some perceive the appearance of new actors such as nongovernmental organizations or scientific networks, the rapid growth of the body of international law and organizations, and the emergence of new forms of regulation such as public-private partnerships, as the emergence of a new system of governance beyond the nation states.²⁶ A more skeptical position argues that international bargaining processes generate insufficient results because of the disparate structure of

19. Wheeler 2001.

20. Faucheux 2000.

21. Drezner 2001.

22. See for example, European Commission 2001.

23. Hoberg 2001, 213.

24. Hay and Rosamond 2002; Hoberg 2001; and World Trade Organization 1999, 5.

25. Young 2002; Esty 1999; and Keohane and Martin 1995.

26. Park 2002; Knill and Lehmkuhl 2002; Auer 2000; and Zürn 1998.

interests and an unclear hierarchy for decision-making.²⁷ Both lines of argument postulate a declining importance of the role of nation states.

Our argument is different. We argue that empirical evidence indicates that the nation state still has considerable room for maneuver, and that pioneering policies of national governments remain possible. When and how such pioneering policies are likely and feasible is the focus of our following analysis.

Our starting point is that environmental innovations are adopted differently and at different points of time in different countries. Some countries innovate earlier, and the penetration of their markets with new products or processes is more encompassing than others. If these innovations are subsequently adopted without major changes in other countries, we will define, and analyze, those countries where the first market introduction took place, as "lead markets." The concept of "lead markets" has been developed and fruitfully applied for several non-environmental innovations, for example mobile phones in Finland, the facsimile machine in Japan, or the Internet in the USA.²⁸ In all these cases, product or process innovations that were designed to meet local preferences and conditions could be introduced and commercialized in other markets without significant modifications.²⁹

In this article, we will discuss lead markets for environmental innovations. Indeed, the history of environmental protection is rich in examples for lead markets, such as 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 technology in Germany. Another example is the global diffusion of chlorine-free paper, from early political activities by Greenpeace and the US Environmental Protection Agency through the introduction of chlorine-free paper whitener in Scandinavian countries and Greenpeace campaigns in Germany and Austria to the eventual political market intervention in Southeast Asian countries like Thailand.³⁰ This example also indicates that internationally successful innovations are not only stimulated by governmental agencies, but in some cases also by environmentalists.

Lead Markets for Environmental Innovations

Lead markets can be identified by the rate of market penetration in different countries. In lead markets, diffusion processes start earlier, and market penetration is typically more complete than in other countries. An example is the catalytic converter for automobiles.³¹ Here, California had become the pacesetter for air quality and automobile emission standards in the 1960s. In 1970, the

27. Suranovic 2002.

28. Beise 2001.

29. Beise 1999.

30. Mol and Sonnenfeld 2000; and Beise et al. 2003.

31. For more detailed discussion, see Beise et al. 2003.

United States congress adopted these standards, which could at that time not be met with existing technologies—a first example of technology forcing through policy. The short time permitted to implement the new standards, however, did not allow for the development of an entirely new engine design. Hence, the catalytic converter became the dominant technical strategy for emissions reduction.

The US regulations have later been adopted in several countries with automobile industries. Japan, in particular, adopted the US regulations early to adapt its car industry to global markets and enhance its competitiveness. While the United States later lowered its standards because of successful intervention of the national car industry, Japan stuck to its earlier objectives. In Europe, regulations in favor of catalytic converters were adopted in 1985, with Germany taking a leading role due to its export-oriented automobile industry.

What determines the differences in the introduction of environmental innovations? What are the characteristics of the leading countries? What is the room for maneuver for the creation of lead markets for environmental innovations? From our case studies as well as from other research we can conclude that technical environmental innovations are largely a consequence of governmental—or, in some cases, nongovernmental—actions. Environmental innovations are not only stimulated by higher environmental preferences of consumers in a particular country, but also by special promotional measures or by political intervention in the market.³² If new technologies bring about additional costs without additional benefits for users, regulatory interventions seem to be even indispensable for innovation and diffusion. But also in the case of integrated technologies that have additional advantages in efficiency, policy measures are often necessary to stimulate innovations and to support the subsequent diffusion.³³

Regarding the subsequent diffusion of environmental innovations, it seems that they have one characteristic that supports their diffusion—they provide marketable solutions to environmental problems that occur in many countries, if not worldwide, at the same time. Technological solutions to environmental problems therefore tend to be adopted in international or global markets. This does not explain, however, the significant regional differences in the adoption and diffusion of innovations, which need to be analyzed in the context of specific framework conditions and political strategies at the national level. This will be discussed in the following sections.

Political Determinants of Pioneering Policies and of their Diffusion

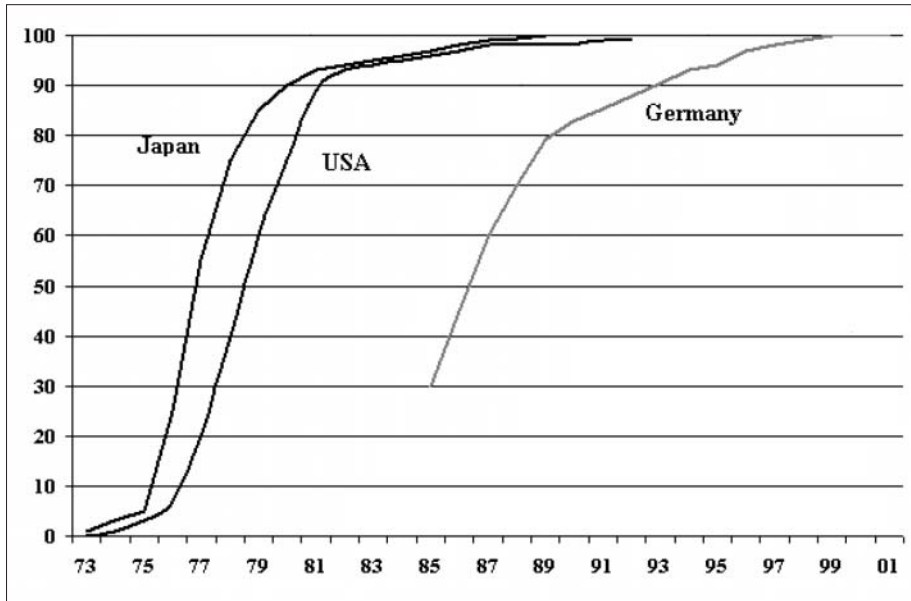
The nation state is both the subject and object of environmental policy learning and lesson-drawing (benchmarking). National governments search for best

32. Klemmer et al. 1999; and Jänicke et al. 2000.

33. Rennings 2000.

Figure 1

Share of passenger cars equipped with catalytic converter in percent



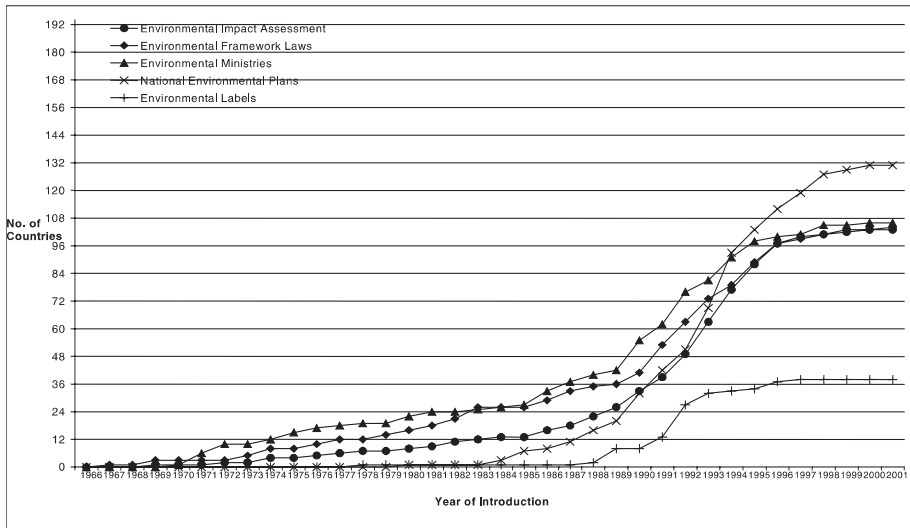
Source: Beise, Blazejczak et al. 2003.

practice in environmental policy-making.³⁴ Successful environmental policy innovations—institutions, instruments or strategies—are thereby often adopted by other governments. This “diffusion by imitation” is an important mechanism of global environmental policy development and policy convergence. International agencies such as OECD and UNEP, or international regimes, are policy arenas for pioneers and serve as agents of diffusion of environmental policy innovations. The role of the pioneers seems to be more important than the creation of policy innovations by the international institutions themselves. Figure 2 shows some examples of the diffusion of environmental policy innovations—such as environmental ministries or green plans—from pioneer countries to the rest of the world.

Innovative environmental policy measures of pioneering countries spread internationally. The rate of diffusion depends on (1) the type of policy innovation (e.g. distributive measures diffuse more easily than redistributive measures), (2) the type and difficulties of the underlying problem, (3) the environmental policy capacity of the potential adopters, and (4) the successful

34. Rose 1993; Bennett 1991; Kern et al. 2001; and Tews et al. 2003.

Figure 2
The Global Diffusion of Environmental Policy Innovations



Source: Busch and Jörgens forthcoming.

influence of international organization—but also of strategic countries—in support of the diffusion. There is a range of governmental or nongovernmental international organizations that develop strategies to spread best practice in the field of environmental policy-making. The OECD is active in this direction, and the institutional fabric of the European Union seems comparatively favorable for both innovations and their diffusion.³⁵ The mechanism of international diffusion of policy innovations is favorable to the creation of lead markets for environmental innovations. The convergence of standards and regulations implies—in case of technology-based policies—a widening of the market for technologies, and the availability of technical solutions makes the diffusion of policy innovation more likely.

Globalization has created a policy arena for pioneer countries, at least in environmental policies. Pioneering environmental policies of highly developed countries can be observed since the 1970s. The influence of small innovative countries in global policy has been growing since.³⁶ There is a political competition between countries that requires an arena. International agencies like OECD or UNEP and global networks of all kind provide a basis for benchmarking and

35. Héritier et al. 1994.

36. Andersen and Liefferink 1997; and Jänicke and Weidner 1997.

competition in global environmental policy. The competition is motivated by the willingness to support domestic innovative industries or to protect the national regulatory culture against pressures to adapt to policy innovation from abroad.

Table 1 presents the counts for the introduction of twenty different policy innovations and the three early adopters for those countries that have been most innovative since the 1970s. It shows that particularly Japan and the United States lost their former role as pioneer.

Contrary to the race-to-the-bottom-hypothesis, our empirical research on the development of environmental policy confirms that it is most often *pioneering nation states* that push for advances in global environmental policy. As far as these policy innovations are technology based—aimed at improving the conditions for the development of environmental innovations and/or their diffusion—these pioneering countries often serve as regional starting points for new technologies. The lead markets in our case studies are empirically characterized by high per-capita income, demanding buyers, high and internationally recognized quality standards, and flexible and innovation-friendly framework conditions for producers and users of technologies.³⁷

It is the high-income countries that are able to afford the necessary investments in research and development for the development of new technologies. Many of them have also the demand conditions that enable environmental lead markets. These markets have to deal with the teething troubles of innovations, and they have to provide the pay back of investments in research and development. They demonstrate the feasibility of technologies on a large-scale application. Successful lead markets are not only connected with potential first-mover advantages, they also can attract investors for environmental friendly technologies, as it is the case in Germany for renewable energies. The highly developed countries are characterized by both high environmental pressure (objective and subjective, induced by high education and income) and high capacity to react (including the institutional basis, administrative competence, economic/fiscal resources, knowledge and the strength of NGOs).

There are *demand-driven* lead markets, that is, nations with higher environmental standards, leading to a widespread adoption to environmental friendly technologies. Examples for this case are the Californian exhaust gas standards for automobiles or the Swedish regulations regarding the use of cadmium. Other lead markets are driven by the *supply* of innovative technologies. Frequently, the producers of technologies seek to extend their markets and therefore lobby for international support of their technologies.

By setting up demanding environmental standards, pioneer countries in environmental policy may send out a twofold signal beyond the boundaries of their national market. First, a national market for environmentally friendly technology acting as a basis for subsequent expansion to bigger markets. The

37. See also Meyer-Krahmer 1997.

Table 1

The Pioneer Countries in Environmental Policy:³⁸ Policy Innovation or Early Adoption 1970–2000³⁹

<i>Country</i>	<i>1970—1985</i>	<i>1985—2000</i>
Sweden (11):	7	4
USA (10):	8	2
Japan (9):	8	1
Denmark (9):	5	4
Finland (8):	4	4
France (7):	5	2
Germany (7):	5	2
The Netherlands (7):	3	4
UK (6):	4	2
Canada (6):	2	4
	51	29

pioneer country demonstrates the economic, technical and political feasibility of its standards and regulations. Subsequently, other countries adopt the innovative regulation. The diffusion of policies, e.g. throughout the European Union, can bring appropriate market expansion. Frequently, the national producers support the international diffusion, if they are able to adapt successfully to the new standards.⁴⁰ A diffusion of regulations will be more likely if a country has attained the image of being a pioneer. Only a few countries nowadays, mostly members of the European Union, serve as the benchmark for the development of environmental policy.

Second, the pioneer market with its demanding environmental regulations can also send signals to the supply side outside the domestic market. For example, California, with its stricter emission rules compared with the rest of the United States, was able to exert a general influence on the car industry worldwide.⁴¹ Today, Californian emission standards exert a considerable influence on car manufactures once again, to develop zero-emission vehicles. Similarly, Denmark, in 1994, with its targeted promotion of energy-efficient refrigerators, was able to prompt European suppliers to offer such devices.⁴² In cases like these, competitive companies can advertise their ability to supply such

38. Definition: PCEPs are innovators or early adopters of new environmental policy measures that diffuse into other countries (thereby contributing to the development of global environmental policy).

39. Introduction of 20 new environmental policy institutions, laws or instruments: innovation plus first three adoptions. Preliminary data.

40. See the examples in Jacob 1999.

41. Vogel 1995.

42. Jänicke et al. 1999.

demanding market areas as a sign of their technological competence. It can be cost efficient to orient the production to the highest standards, if there are scale effects.

The emergence of lead markets for an environmental technology takes place in two stages, of which the first is the most important. The first phase is defined by the struggling for success on the national market. This includes the establishment of a national market (not only a protected niche market) and successful incremental improvements of the product and its production. Government instruments may be standards, subsidies, charges, labels, public procurement, network management, or Eco-Management and Audit Schemes (demand of firms).

The second phase is defined by government support for technology transfer by activities within international organizations (e.g. diffusion of the supporting policy pattern), bilateral actions with strategic countries, special international conferences, reporting by the international media, and cooperation with international NGOs etc. More important may be—on the demand situation—the diffusion motor of benchmarking and search for best practices, which in many countries is an institutionalized mechanism today. In addition, the cooperation with multinational companies may be a relevant transfer mechanism.

If successfully established, such markets may fulfill a range of functions. From a *global* perspective, they provide marketable solutions for typical environmental problems. Lead markets in high-income countries are able to raise the necessary funds for refinancing the costs for development and learning. This is true for environmental innovations in particular. There is a need to overcome the teething troubles of new technologies. They are demonstrating both the technical and the political feasibility and thereby giving a stimulus for other countries and enterprises to adapt to their pioneering standards. From a national perspective, ambitious standards or support mechanisms might save first-mover advantages for the own industries. Furthermore, the creation of demand by ambitious policies can attract foreign investors that are interested in the development and marketing of environmental innovations. Finally, a demanding policy that holds economic advantages additionally legitimates the national policy-makers, sometimes providing them with attractive roles in the global arena.

Strategies for the Establishment of Lead Markets

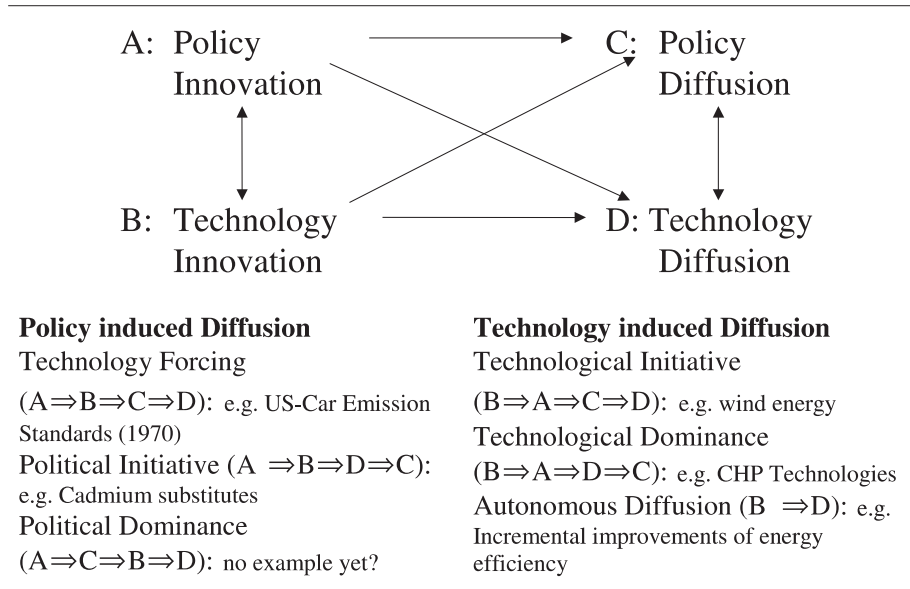
Policies that are likely to promote the emergence of environmental innovations have been described and analyzed by several authors, including the “multi-impulse hypothesis”⁴³, “design criteria” for environmental policies⁴⁴, or “strategic niche management.”⁴⁵ The development of lead markets, however, focuses

43. Blazejczak et al. 1999.

44. Norberg-Bohm 1999.

45. Kemp et al. 1998.

Figure 3
Diffusion Patterns of Environmental Innovation (Jänicke 2000)



on the diffusion of green technologies, without neglecting the need for measures to support their development.

There is a convergence of interests between innovative firms and environmental policy-makers. Suppliers of environmental technology seek the support of politicians in order to extend their markets, and political actors search for technological options, since these are much easier to implement than any sort of structural intervention. Policies based on technologies that have demonstrated their feasibility are more likely to diffuse to other countries.

The interplay between the diffusion of environmental policy measures and environmental technology can take a wide variety of possible sequences. Figure 3 depicts a stage model of policy and technology innovation and their respective diffusion. Theoretically, it is possible to distinguish between the following diffusion scenarios, depending on the factors leading to the political and technological innovations.

Technology forcing ($A \Rightarrow B \Rightarrow C \Rightarrow D$): A national environmental policy innovation in one country forces a technological innovation that diffuses if the policy innovation diffuses (e.g., catalytic converter technology in cars).

Technological initiative ($B \Rightarrow A \Rightarrow C \Rightarrow D$): An existing environmental technology induces a political innovation whose diffusion in turn encourages the diffusion of the technology (e.g., wind energy in Denmark).

Political initiative ($A \Rightarrow B \Rightarrow D \Rightarrow C$): A national environmental policy leads to technological innovations whose diffusion in turn encourages diffusion of the policy innovation (e.g., cadmium substitute⁴⁶).

Technological dominance ($B \Rightarrow A \Rightarrow D \Rightarrow C$): An innovation in environmental technology is successfully diffused and receives as a result political support both nationally and internationally (e.g., combined heat and power in industry⁴⁷).

Political dominance ($A \Rightarrow C \Rightarrow B \Rightarrow D$): The innovation in environmental policy is successfully diffused before a corresponding technology is available (this scenario is, symptomatically, very rare in ecological modernization).

Autonomous technological development ($B \Rightarrow D$): An innovation in environmental technology is successfully diffused without political influence; this case, beyond incrementally increasing energy efficiency in companies, seems to be rather rare.

Technological innovation provides additional options for policy-makers. Regulations are thus set up that support the diffusion of environmentally friendly technologies. For other cases, policy factors have been the major driving forces in the stimulation of environment-friendly technical innovations. The case of technology forcing, however, has been exceptional for environmental innovation.⁴⁸ So far, environmental policy has its merits in the promotion of the diffusion of technologies within and between countries. Autonomous emergence and diffusion of innovations in environmental technology is the exception and usually remains limited to incremental increases in efficiency in companies.

The different variants of innovation and diffusion of technologies and policies hint to a variation in the degree of political difficulty of the underlying strategies. Policy-makers that may refer to other countries where both the technical and political feasibility has been proven may legitimize their initiatives more easily than those who aim to regulate issues without the possibility to refer on existing technologies or policies, as it is the case the technology forcing approach. In this case distributive policy instruments, in particular subsidies for research and development, are easier to be implemented, while for the diffusion of existing technologies re-distributive instruments and regulative approaches are more effective and efficient.

Conclusion

The limits of ecological modernization (in the “technocratic” sense⁴⁹) are defined by the limits of technology. These limits, however, are dynamic. They

46. Sweden regulated the use of cadmium in the early 1980s, and the standards for substitutes were later adopted by European industry. Not until the early 1990s, however, were these standards made binding by the European Commission (Bätcher et al. 1992).

47. Combined heat and power (CHP) in industry spread largely autonomously, even though regulatory measures were intended to encourage its use in public power stations.

48. Conrad 1998; Jacob 1999.

49. See Jänicke 2000 for a more detailed discussion on the different concepts of ecological modernization.

can be extended by research (and by research and development policies). For example, research into the development of procedures for reducing carbon dioxide emissions, if successful, could substantially widen the room for maneuver in climate policy. The rapid diffusion of suitable policy innovations will then be predictable. The current climate policy, which aims at structural change of the energy sector at the expense of coal and oil industries, faces resistance by these sectors, which explain its difficulty and slowness. The variants of this interplay between policy and technology in any case are a central theme in research on the diffusion of environmental innovations, especially when it comes to selectively optimizing such innovations.

Ecological modernization driven by pioneering countries can be conceived, and has its merits, as a market-compatible strategy of technical environmental innovations and corresponding policies supporting their diffusion. The (highly developed) nation state plays a crucial role in this context. In this perspective, the function of international organizations can be seen more as policy arenas for pioneer countries and as agents of diffusion than as original policy innovators.

Furthermore, there is no race to the bottom in times of economic globalization. The present pioneers in environmental policy are primarily open economies. There is no general contradiction between competitiveness and demanding environmental policy, on the contrary, highly developed countries tend to integrate the environmental issue into the competition on quality. The highly regulated markets and their environmental standards—e.g. in the European Union—strongly influence other exporting nations. Global diffusion of best practice in environmental policy has become an important driving force for the diffusion of marketable technical solutions for environmental problems that typically exist on a global scale.

So far, however, there are serious shortcomings of ecological modernization. In complex issue areas such as climate change or ground water protection, more environmental protection is clearly required. Only incremental innovations limited to niche markets in a few countries are not sufficient. Radical innovations applied on a global scale may bring the necessary changes. The conditions for a global strategy of ecological modernization, however, are not bad.

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