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Regulation-Induced Innovation for Sustainable Development

By Nicholas A. Ashford and Ralph P. Hall*

This article argues that regulation—properly fashioned—can transform products and processes in ways that confer economic, health, safety, and environmental benefits—not only costs. In contrast, classical economic analysis of the relationship between health, safety, and environmental regulation, on the one hand, and competitiveness, on the other, maintains that stringent regulation invariably increases production costs, diverting resources from R&D and hindering innovation. This assumption was challenged first in the late 1970s at MIT and made popular in 1991 by the so-called “Porter hypothesis.”

The Porter hypothesis and the relevant literature indicate that environmental, health, and safety regulation can induce dramatic innovations, not only by spurring the development of new products or services by incumbent producers, but also by creating conditions in which new producers can enter the field. Regulation can do this when firms have, or are induced to have, the willingness, opportunity, and capacity to innovate. This literature, and the insights gleaned from it, provide an important set of clues for how regulation can be used to foster sustainability.

Based upon his research into the competitive advantage of nations, Porter claimed that “[s]trict environmental regulations do not inevitably hinder competitive advantage against foreign rivals; indeed, they often enhance it. Tough standards trigger innovation and

upgrading.” He observed that “[p]roperly constructed regulatory standards, which aim at outcomes and not methods, will encourage companies to re-engineer their technology. The result in many cases is a process that not only pollutes less but lowers costs or improves quality. . . . Strict product regulations can also prod companies into innovating to produce less polluting or more resource-efficient products that will be highly valued internationally.” Porter’s hypothesis is that firms which respond to stringent regulation by developing new technologies have a “first mover” advantage and can capture the market for their products/services. Comparison of national competitiveness with good environmental governance and private-sector responsiveness supports the Porter hypothesis. Good economic management and good environmental management are related, and firms which succeed in developing innovative responses to environmental challenges benefit both environmentally and economically.

Earlier empirically based work on this concept dates back twelve years before Porter’s work, to research undertaken at MIT. This earlier work showed how stringent and focused regulations in the U.S. chemical-producing and -using industries had the effect of stimulating fundamental product and process innovations. The MIT studies revealed that *environmental and health and safety regulation*—if appropriately designed, implemented, and complemented by economic incentives—can lead to radical technological developments that can significantly reduce exposure to toxic chemicals in the natural and working environments and in consumer products. Examples include regulation-induced replacement of poly-chlorinated biphenyls used in transformers by a silicone-based fluid, a new polymerization process for polyvinylchloride, and

textile-weaving innovation eliminating the need for a formaldehyde-containing resin that imparted permanent press properties to cloth.

A limitation of Porter’s hypothesis is that it focuses on how incumbent firms respond to more stringent regulations, but it ignores the important dynamics of new entrants. Porter and van den Linde argue that regulation, properly designed, can cause a regulated firm to undertake innovations that not only reduce pollution—which is a hallmark of production inefficiency—but also save on materials, water, and energy costs, conferring what Porter calls “innovation offsets” to the innovating firm (and what Ashford and his MIT colleagues called “ancillary benefits”). This can occur because the firm, at any point in time, is sub-optimal. If the firm is the first to comply with regulation in an intelligent way, other firms will later have to rush to comply and do so in a less thoughtful and more expensive way. Thus, there are learning curve advantages to being first and early.

Given Porter’s focus on innovation offsets—i.e., the cost savings due to induced innovation that could exceed the cost of the regulation—he is mainly concerned with the costs to incumbent firms. However, it is possible to differentiate between “weak” and “strong” forms of the regulation-induced innovation hypothesis—a distinction that Porter does not make. In its weak form, as Porter observes, firms subject to more stringent regulation respond with product and process innovations. However, while environmental and worker health and safety improvements may be realized, the offending products and processes are only incrementally changed.

In contrast, in the strong form of the regulation-induced innovation hypothesis, stringent regulation can stimulate

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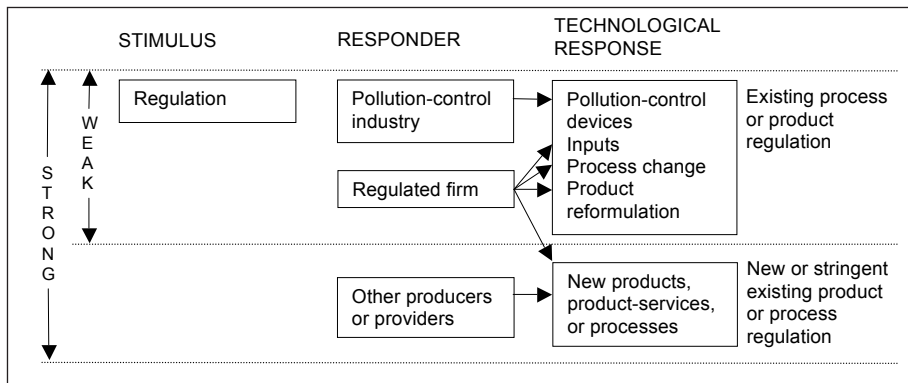


Figure 1: A model for regulation-induced technological change for weak (Porter) and strong (Ashford/MIT) forms of the regulation-induced innovation hypothesis.

the entrance of entirely new products and processes into the market, thereby displacing dominant technologies. In this situation, unless incumbent firms have both the willingness and the capability to produce and compete with the new forms of technology, they too are likely to be displaced from the market. The figure below provides a simple diagram of the likely technological responses to the strong and weak forms of the regulation-induced innovation hypothesis. Empirically based examples were researched by Ashford and his colleagues in their work.

While some question whether environmental regulation does generate a positive effect on innovation, their analyses tend to miss the essence of the strong form of the regulation-induced innovation hypothesis. Although it is likely that stringent regulation will not stimulate technological innovation in most firms, some firms are likely to rise to the challenge and become technological leaders in the process. Hence, the evidence is necessarily anecdotal. The Schumpeterian notion of “waves of creative destruction” leading to succeeding advances in technological development describes the process by which dominant technologies are being continually displaced as new technologies become available.

The design challenge facing government is how existing undesirable technologies can be retired (or displaced) through a combination of regulation and market incentives. These ideas thus challenge the notion that incumbent firms will reinvent themselves in a significant way and should have a major role in

setting the targets for future regulation. Incumbents will not set targets that they do not expect they can meet.

With regard to the weak form of the regulation-induced innovation hypothesis, ambitious environmental policies in developed nations can lead to the formation of lead markets for environmental technologies. However, the evidence suggests that the international diffusion of environmental innovations must be accompanied by international policy diffusion, or the adoption by other countries of the induced innovation must be economically reasonable. Both of these factors make it difficult to predict with certainty whether an ambitious environmental policy is likely to create a lead market for the international diffusion of innovations. The uncertainty surrounding the likely impacts on national industries of more stringent environmental, health, and safety regulation is seen as one reason why governments hesitate to implement such policies.

Stringent regulation can stimulate new entrants to introduce *entirely new products and processes* into the market—products and processes that will displace dominant technologies. One of several vivid examples is the displacement of Monsanto’s PCBs in transformers and capacitors by an entirely different dielectric fluid pioneered by Dow Silicone. Regulation can thus encourage disrupting innovations by giving more influence to new customer bases, in which demands for improvements in both environmental quality and energy use and efficiency are more sharply defined and articulated. Of course, industries that would fear being displaced by new entrants would not be

expected to welcome this regulation. This explains in part their resistance to regulation and their propensity to try to capture regulatory regimes, surreptitiously or through direct negotiation with government.

In principle, regulation can be an effective and proper instrument for government to guide the innovation process. Well-designed regulation that sets new rules changes the institutional framework of the market. It can thus be an important element in creating favorable conditions for innovation that will enhance environmental sustainability and create incentives for the development of powerful lead markets, which pull innovation towards that sustainability. With regard to regulation, what seems to matter is not only the stringency, mode (specification versus performance standards), timing, uncertainty, focus (inputs versus product versus process) of the regulation, and the existence of complementary economic incentives—but also the inherent innovativeness (usually in new entrants) or lack of it (usually in the regulated firms) that the regulation engenders.

In order for innovation to occur, the firm (or government itself) must have the *willingness, opportunity/motivation, and capability/capacity* to innovate. These three factors affect each other, of course; but each is determined by more fundamental factors.

Willingness is determined by the following factors: (1) attitudes towards changes in production in general; (2) an understanding of the problem; (3) knowledge of possible options and solutions; and (4) the ability to evaluate alternatives. Improving factor (3) involves aspects of capacity building through the diffusion of information, through trade associations, government-sponsored education programs, inter-firm contacts, and the like. Changing attitudes towards changes in production, factor (1), often depends on the attitudes of managers and on the larger culture and structure of the organization, which may either stifle or encourage innovation and risk taking. Factors (2) and (4) depend on internal intellectual capacities. In the context of disrupting innovation by firms representing the dominant technology, willingness

is also shaped by the rare commitment of management to nurture new approaches that are at odds with its traditional value network or customer base.

Opportunity and motivation involve both supply-side and demand-side factors. On the supply side, technological gaps can exist between the technology currently used in a particular firm and the already-available technology that could be adopted or adapted (known as diffusion or incremental innovation, respectively), or alternatively the technology that could be developed (i.e., significant sustaining or disrupting innovation). Consciousness of these gaps can prompt firms to change their technology, as can the opportunity for cost savings. Regulatory requirements can also define the changes that would be necessary to remain in the market. On the demand side, three factors could push firms towards technological change. These are: (1) opportunities for cost savings or expansion of sales; (2) public demand for more environmentally sound, eco-efficient, and safer industry products, and services; and (3) worker demands and pressures arising from industrial relations concerns. The first

factor could result from changes in the customer value networks. However, all these factors may stimulate change too late in the dominant technology firms, if new entrants have already seized the opportunity to engage in developing disrupting innovations.

Capability or capacity may actually be the most important and limiting factor and can be enhanced by: (1) an understanding of the problem; (2) knowledge of possible options and solutions; (3) the ability to evaluate alternatives; (4) resident/available skills and capabilities to innovate; and (5) access to, and interaction with, outsiders. Knowledge enhancement/learning, factor (2), can be facilitated through deliberate or serendipitous transfer of knowledge from suppliers, customers, trade associations, unions, workers, other firms, and the available literature. The skill base of the firm, factor (4), can be enhanced through the education and training of operators, workers, and managers, on both a formal and informal basis, and through the deliberate creation of networks and strategic alliances that are not necessarily confined to a geographical area, nation, or technological regime.

Interaction with outsiders can stimulate more radical and disrupting changes. This last method of enhancing the capacity of firms to undertake technological change involves new outsider firms and stakeholders with which the firm has not traditionally been involved. Capacity to change may also be influenced by the innovativeness (or lack thereof) of the firm as determined by the maturity and technological rigidity of a particular product or production line. Some firms find it easier to innovate than others. The heavy, basic industries, which are also sometimes the most polluting, unsafe, and resource-intensive industries, change with great difficulty, especially when it comes to core processes. New industries, such as computer manufacturing, can also be polluting, unsafe (for workers), and resource and energy intensive, although they may find it easier to meet environmental demands. Government should not miss the opportunity to loosen the creative forces that bring about innovative changes that can simultaneously benefit the economy, the environment, and the general welfare. 