



By Robert N. Stavins

Policies Can Work In Strange Ways

To assess the effects of laws and regulations on environmental performance, it is necessary to understand the interaction between regulations and technological change. Several years ago, Professor Lori Benneer of Duke University, Professor Nolan Miller of Harvard, and I examined the effect of regulation on technological change in chlorine manufacturing by focusing on the diffusion of membrane-cell technology, environmentally superior to both mercury-cell and diaphragm-cell technologies. Our results were surprising.

The chlorine industry has experienced a substantial shift over time toward membrane technology. Two processes have driven this shift: switching to cleaner technologies at existing plants (adoption), and the closing of facilities using diaphragm and mercury cells (exit). We considered the effects of both direct regulation of manufacturing and regulation of downstream uses.

In 1972, a widely publicized incident of mercury poisoning in Minamata Bay, Japan, led its government to prohibit mercury cells. The U.S. did not follow suit, but it did impose more stringent constraints on mercury-cell units. Chlorine manufacturing became subject to increased regulation under the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act, and Superfund. In addition, chlorine manufacturing became subject to the Toxics Release Inventory.

Along with regulation of the manufacturing process, there has been increased environmental pressure on industries that used chlorine as an input. This indirect regulation was potentially important for choices of manufacturing technology because a large share of chlorine is manufactured for onsite use in the production of other chemicals. Changes in regulations in downstream industries could have substantial impacts on the demand for chlorine and thereby affect the rate of entry and exit of production plants.

Two major indirect regulations altered the demand for chlorine. One was the Montreal Protocol, which regulates the production of ozone depleting chemicals, like chlorofluorocarbons, in which chlorine is a key ingredient. The other important indirect regulation was the sector-wide “cluster rule,” which tightened release of chlorinated compounds from pulp and paper mills to both water and air. This led to increased interest by the industry in non-chlorine bleaching agents, which in turn affected the economic viability of some chlorine plants.

We looked at the effects of economic and regulatory factors on adoption and exit decisions by chlorine plants from 1976 to 2001. For our analysis of adoption, we employed data on 51 facilities, eight of which had adopted the membrane technology during the period we investigated. We found that the effects of the regulations on the likelihood of adopting membrane technology were not statistically significant. Mercury plants, which were subject to stringent regulation for water, air, and hazardous-waste removal, were no more likely to switch to the membrane technology than diaphragm plants. Similarly, TRI reporting appeared to have had no significant effect on adoption decisions.

We also examined what caused plants to exit the industry, with data on 55 facilities, 21 of which ceased operations between 1976 and 2001. Some quite striking patterns emerged. Regulation clearly explained some of the exit behavior. In particular, indirect regulation of the end-uses of chlorine accelerated shutdowns in some industries. Facilities affected by the protocol and the cluster rule were substantially more likely to shut down than others.

It is good to remember that the diffusion of new technology is the result of a combination of adoption at existing facilities and entry and exit of facilities with various technologies in place. In the case of chlorine manufacturing, our

“This is a legitimate way for policies to operate, although it’s one most politicians would probably prefer not to recognize.”

results indicated that regulatory factors did not have a significant effect on the decision to adopt the greener technology at existing plants. On the other hand, indirect regulation of the end-uses of chlorine accelerated facility closures significantly, and thereby increased the share of

plants using the cleaner membrane technology for chlorine production.

Environmental regulation did affect technological change, but not in the way many people assume it does. It did so not by encouraging the adoption of some technology by existing facilities, but by reducing the demand for a product and hence encouraging the shutdown of facilities using environmentally inferior options. This is a legitimate way for policies to operate, although it’s one most politicians would probably prefer not to recognize. ❧

Robert N. Stavins is the Albert Pratt Professor of Business and Government at the John F. Kennedy School of Government and Director of the Environmental Economics Program at Harvard University. He can be reached at robert_stavins@harvard.edu.