POLICY FORUM

SCIENCE AND REGULATION

Looking backward to move regulations forward

Rigorous ex post analyses can improve regulatory policies

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Research-based evidence is critical for understanding and improving the impact of government regulation on society. Positions promoted by the Trump Administration question the effectiveness of many regulations, making their rigorous analysis all the more critical. Yet such research is relatively rare, especially for environmental rules, the most costly type of federal regulation in the United States (*1*). The principal source of information on costs, benefits, and distributional consequences of major regulations are ex ante studies such as regulatory impact analyses (RIAs) routinely conducted on proposed rules by U.S. federal agencies. Despite their rigor and complexity, RIAs are developed at "the point when the least is known and any analysis must rest on many unverifiable and potentially controversial assumptions" (*2*). By contrast, retrospective analysis can reaffirm (or question) the effectiveness of rules and the accuracy of RIAs and thereby aid the rational allocation of societal resources. Despite this advantage, many obstacles prevent widespread development of such ex post analyses. We discuss approaches to ex post analysis and suggest steps to broaden its use.

Emissions from this mill in Port Angeles, WA, were subject to the Cluster Rule.

The goal of an RIA is to compute benefits and costs of a proposed regulation relative to a world without the regulation (the no-regulation baseline). In the case of a regulation designed to reduce pollution, ex ante analysis must (i) predict pollutant emissions in both the no-regulation baseline and after the regulation is implemented; (ii) calculate costs of the regulation; and (iii) calculate benefits based on the predicted change in emissions.

To illustrate, the RIA for the U.S. Environmental Protection Agency's (EPA's) 1998 Cluster Rule—designed to reduce hazardous air and water pollutants from pulp and paper mills—specified levels of emissions of dioxins, furans, chloroform, and various air toxics that firms were expected to emit absent the rule. The RIA for EPA's NOx Budget Trading Program (NBP), which capped summertime NOx emissions in the Eastern and Midwestern United States, required estimating baseline seasonal emissions at 2500 electricity-generating units and industrial boilers.

Baseline emissions predictions are sometimes based on historical rates (e.g., mass of pollutant per unit of input or output) with input (or output) levels adjusted to reflect growth in population and incomes. This is problematic in industries where prices and technologies are changing substantially. The choice of baseline is complicated by the fact that firms may reduce emissions in anticipation of a rule; e.g., paper mill dioxin and chloroform emissions decreased markedly before the final Cluster Rule was issued (*3*).

Expected costs of complying with a regulation (relative to the no-regulation baseline) are often measured on the basis of engineering estimates of the installation costs for pollution control equipment. This approach can yield an over- or underestimate when (i) the analysis identifies an incorrect no-regulation baseline, (ii) there are alternate methods of compliance, and/or (iii) production and control technologies are changing.

Expected benefits of regulation are a function of the difference between no-regulation baseline emissions and what the RIA forecasts them to be after regulation. If possible, the emissions difference is translated into changes in ambient air or water quality, which are expressed in terms of health and welfare end points that can be monetized. Benefit estimates will be inaccurate if predicted baseline and/or regulated emissions are incorrect.

PREDICTION OR OBSERVATION?

Ex ante analysis requires that both the no-regulation baseline and the world with the regulation be predicted. Although sensitivity analysis is possible, both with-regulation and without-regulation accurate predictions, scenarios are inherently uncertain. In contrast, after the regulation is implemented, the methods used by firms to comply can in principle be observed, as can actual emissions. Although the counterfactual no-regulation baseline can never be observed for regulated entities, there will be instances in which it can be inferred if a control group of similar, unregulated, or differentially regulated firms is available.

Because not all pulp and paper firms were subject to the Cluster Rule, unregulated firms provided a control group to estimate the rule's impact on air and water emissions, and on employment (*3*, *4*). The resulting no-regulation baseline captured trends that could affect emissions, such as changes in technology and market conditions (*5*). One concern with this approach is that a costly rule may induce a shift in market share from regulated to unregulated plants. It is possible to at least partially control for such spillover effects by including measures to reflect the level of plant production. One could also use a comparison group of unregulated plants in other industries that had no plausible impacts on the regulated units (*6*).

These studies suggest that the Cluster Rule achieved a mixed outcome, with considerable cumulative reductions in chloroform (including some prerule reductions), nearly identical to the EPA's ex ante prediction of 99% reductions (*3*). The rule reduced toxic air pol-

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lutants (e.g., benzene, carbon tetrachloride, and methylene chloride), although these represent only about half of the predicted reduction (*3*, *6*, *7*). No substantial reduction in particles <10 μm in diameter (PM10) emissions was achieved, contrary to EPA's prediction (*3*). Employment declined by 6 to 7% at plants subject to both water and air pollution regulations but not at plants subject only to air regulations (*4*).

It appears that EPA's overestimation of the reduction in toxic releases arose from failure to adequately adjust its no-regulation baseline for early reductions by many plants in response to state or voluntary programs. EPA also made other changes in how it computed emissions in the late stages of rule development. The result is consistent with and

"...retrospective research... can [help] in prioritizing and legitimizing current and future regulatory actions."

complements EPA's recently completed retrospective cost study finding that the agency considerably overestimated the capital costs of the Cluster Rule (*8*).

Recent research examining the NBP used the seasonal nature of the program, as well as the fact that the program covered only states in the East and Midwest, to estimate the program's effect on air emissions, ambient pollution levels, medication costs, hospital visits, and mortality rates (*9*). The study suggests that the NBP achieved major reductions in NOx emissions, lowering summertime ambient ozone levels 6 to 7% relative to the baseline average and reducing by 34 to 42% the number of days exceeding 65 ppb of ozone (i.e., levels close to or exceeding EPA's current ambient ozone standard of 70 ppb). The study indicates that the NBP reduced annual summertime mortality by roughly 2500 deaths—75% of those among the population aged 75 years or older—and reduced expenditures on medications by ~$800 million per year (in U.S.$, 2015). The study found larger impacts of the NBP on ozone-related mortality than the original RIA (*10*) and measured an important category of benefits—reduced medical expenditures—not considered in the RIA. Arguably, these findings could justify a stronger program.

Studies of both rules were possible because relevant data were available. Both studies also identified facilities that were either differentially covered or not covered at all by the regulation to serve as a comparison group. A private firm provided data on compliance costs for ex post analysis of the Cluster Rule (*8*).

MAKING IT WORK

Methodologically, there is no substitute for detailed ex post analysis of regulations. In the spirit of the U.S. Commission on Evidence-Based Policymaking (*11*), we suggest four steps the government can take to facilitate this approach.

Collect data on compliance choices and costs. One reason that the cost of regulations affecting electric utilities can readily be studied is the availability of input and cost data for the electric power sector. Collection of such cost data by federal agencies requires approval by the Office of Management and Budget (OMB). OMB has outlined strategies to expedite approval of science-related research data collection and should extend these options to data collection for retrospective analyses. For the manufacturing sector, the now defunct Pollution Abatement Control Expenditures survey, which collected annual facility-level data on pollution-abatement capital expenditures and operating costs between 1973 and 1994, and again in 1999 and 2005, could be revived. This would facilitate retrospective studies of the manufacturing sector—especially when merged with ongoing facility-level Census Bureau data sets.

Collect facility-level emissions information. The Cluster Rule studies relied on data from the Toxic Release Inventory (TRI). The NBP study used NOx emissions data from the Continuous Emissions Monitoring System (CEMS) mandated by the Acid Rain Program. The TRI collects self-reported data on emissions of >650 toxic substances. CEMS provides real-time measurement of certain gaseous and particle emissions, principally at power plants. It is essential that these data continue to be collected. Municipal facilities and industrial manufacturing plants are required to report air emissions and water discharges of a range of pollutants. EPA should work to make these data more accessible to researchers and the public.

Implement regulations to provide a control group. Although this may not be possible in all cases, one way to facilitate a control group is to phase-in a regulation so that firms randomly assigned to be "later implementers" can serve as controls for firms that are first subject to the regulation. An example of this is Southern California's Regional Clean Air Incentives Market (RECLAIM) cap-and-trade program designed to reduce NOx emissions (*12*). Some federally mandated state-run programs that allow flexibility may also provide suitable control groups.

Formalize requirements for retrospective analysis. Building on recommendations of the Administrative Conference of the United States and others (*13*–*15*), the OMB should formalize guidance for retrospective evaluation of rules. These requirements should be based on the likelihood of identifying the real impacts of the regulations and ought to include the availability of a relevant control group and the associated data for estimating compliance costs and effectiveness (or benefits). Decisions on the appropriate authorship and/or peer-review process for these studies and about funding need to be made by the federal government.

As political conflicts over regulation increase, investment in facilitating retrospective research in both government and academia can play an important role in prioritizing and legitimizing current and future regulatory actions. ■

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