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A Retrospective Study of EPA's Rules Setting Best Available Technology Limits for Toxic Discharges to Water under the Clean Water Act

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Abstract

Under the Clean Water Act, the US Environmental Protection Agency (EPA) is required to establish standards limiting water toxics discharges from industrial plants. This paper examines the effect of EPA's 1998 Pulp and Paper Cluster Rule on the discharge of toxics to the waters of the United States. Our estimates suggest that mills covered by the water limits in the rule achieved little or no additional reduction in water toxics discharges in response to publication of the final rule as compared to mills not subject to the water discharge limits of the rule. This paper also offers some recommendations for improving both ex ante and future retrospective analyses.

Key Words: Clean Water Act, water quality, environmental economics, retrospective studies, regulation

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Introduction

Beginning with the 1972 Clean Water Act (CWA), technology-based standards have been a major part of the effort to clean up the nation's waters. But most accounts of the experience with technology-based requirements present a mixed picture of a glass half full/half empty. On the one hand, the technology-based standards have provided a basic level of control of conventional and toxic pollutant wastewater discharges. On the other hand, establishing these standards required a substantial EPA effort, involved long delays in getting standards in place, and in too many instances, resulted in extensive litigation. Further, disappointed critics of EPA argue that the program has largely failed to reach the basic goals of the CWA by ratcheting down discharge standards to achieve zero discharge (Houck 1991).

It is fairly easy to support this narrative without doing a retrospective study. Certainly, establishing technology-based standards required a major EPA regulatory effort, took years to put in place (standards were not established until long after congressional deadlines), and in some cases involved extensive litigation (Houck 1991). Further, there have not been successive waves of ever more stringent discharge standards culminating in widespread requirements for the recycling of wastewater and zero discharge.

This retrospective study seeks to add to our understanding of what these technology-based toxics standards actually accomplished, suggest ways to improve ex ante analysis of regulations, and offer some lessons on what needs to be done in order to conduct retrospective

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analyses. Section 1 provides some background, including a summary of the literature. Section 2 outlines our methodology, and Section 3 presents the results. Section 4 discusses lessons learned.

1. Background

1.1. Regulatory Context

The Clean Water Act (CWA) requires EPA to set technology-based standards, known as effluent guidelines, to limit the discharge of conventional and toxic pollutants from both industrial and municipal wastewater plants. The initial focus of the 1972 CWA was on the discharge of conventional pollutants such as biological oxygen demand (BOD) and total suspended solids (TSS). But the 1977 amendments to the CWA made a midcourse adjustment to shift the focus of the best available technology economically achievable (BAT) level of control to the discharge of toxic pollutants from industrial facilities.[1] Thus, under the 1977 Amendments to the Clean Water Act, the BAT level of control became the principal national means of controlling toxic discharges into the waters of the United States (60 FR 21599).

The CWA provides the following guidance for setting technology-based BAT effluent limits:

> Factors relating to the assessment of best available technology shall take into account the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, the cost of achieving such effluent reduction, non-water quality environmental impact (including energy requirements), and such other factors as the Administrator deems appropriate.[2]

In setting BAT, EPA identified subcategories within the industry (reflecting differences in processes, age of the plants, and so on) and a set of technology options that would reduce the discharge of toxics. After selecting a specific technology basis, taking into account such factors as the effectiveness of control, the remaining level of toxics in the discharge, and the cost of

[1] The impetus for the 1977 Amendments requiring EPA to shift its focus to the setting of effluent guidelines for toxic discharges to water came in large measure from the 1976 NRDC EPA consent decree (the so-called Flannery Decision). This decision mandated that EPA promulgate rules to control 65 toxic pollutants discharged into waters of the United States by 21 industrial categories (O’Leary 1990). The 1977 Amendments also require EPA to set pretreatment standards for existing sources (PSES) for indirect dischargers whose waste goes to publicly owned treatment works and new source standards for both direct and indirect dischargers.

[2] 33 US Congress 1314(b)(2)(B).

control, EPA converted its selected technology into "performance-based" effluent limits for each subcategory.

In the 1980s, EPA issued the initial round of industrial water pollution control regulations addressing toxic pollutants, known as effluent guidelines, pursuant to the 1977 CWA Amendments. EPA reviewed the toxic discharges of 24 primary industries, establishing BAT standards for direct discharging plants in 16 of these industries.[3]

Beginning in the late 1980s, EPA launched several programs affecting the use of toxic substances. The Toxics Release Inventory (TRI) program required mandatory reporting of annual releases of toxics to the air, water, and land and off-site transfers by plants in the manufacturing sector. TRI reporting began in 1988; some studies suggest that covered facilities significantly reduced their toxic releases in the initial years of this program.

EPA also launched several voluntary programs to reduce the use and release of toxics beginning in the early 1990s. These programs included the 33/50 Program (with the targets of a 33% reduction by 1992 and 50% reduction by the end of 1995 in the release or off-site transfer of 17 target chemicals), Common Sense Initiative (1994–1998), Project XL (1995–2003), and National Environmental Performance Track (2000–2009).

In addition, a number of states adopted both regulatory and voluntary programs in the 1980s and early 1990s to reduce the use and release of toxics. Twenty-seven states had pollution prevention programs in place by 1990, and 48 states had such programs in place by mid-1991. These programs ranged from voluntary technical assistance to mandatory toxics use reduction goals (Bui and Kapon 2012).

1.2. Literature Review

Relatively little research has evaluated retrospectively the industry-specific, technology-based effluent guidelines for the discharge of toxic pollutants that EPA has issued to implement the Clean Water Act.[4] While some studies have examined the effect of best practicable

[3] Also see http://water.epa.gov/scitech/wastetech/guide/questions_index.cfm#pses for more information. In subsequent years, EPA has revised some of these rules to reflect the availability of additional control technology (e.g., pulp and paper and pharmaceutical industries). It is continuing to issue rules for additional source categories outside the traditional manufacturing sector. For example, EPA is currently developing coalbed methane extraction, shale gas, and dental amalgam effluent guidelines.

[4] Literature search was limited to EconLit and Google Scholar.

technology currently available (BPT) level limits on the discharge of conventional pollutants, very little has been done to examine the effect of the BAT toxics program on toxic water discharges.[5]

EPA conducted a 2006 study with the objective of examining the implementation of the 1998 Cluster Rule and determining the effect of the rule on pulp and paper mill discharges.[6] Based on available Permit Compliance System (PCS) data,[7] EPA estimated a 97% to 98% reduction in production-normalized loadings of chloroform over the 2001 to 2004 period from an EPA calculated 1995 baseline for loadings (EPA 2006).[8] For adsorbable organic halides (AOX),[9] EPA estimated a reduction on the order of two-thirds in production-normalized loadings from its calculated 1995 baseline but offered a more modest estimate of the reduction in total AOX loadings of 2 million pounds (12% reduction) in 2004 to 5 million pounds (30% reduction) in 2002 from a 1995 baseline of 17 million pounds.[10]

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[5] Harrington (2003) presents a survey of the available literature and data on the effectiveness of CWA regulation of conventional and toxic discharges by industrial and municipal wastewater plants. This survey largely focuses on conventional pollutant discharges; however, Harrington notes that EPA reported that most plants were meeting their permit limits for toxics over most of the period from the mid-1980s to the mid-1990s. But more than half of these direct dischargers had less stringent best professional judgment (BPJ) limits instead of BAT limits for toxics. Thus Harrington suggests that "direct dischargers may have achieved significant effluent reductions by 1994, but they had not achieved the reductions anticipated in the BAT standards" (20). Other research on the effluent guidelines program focuses on the analysis of ex ante information on costs and cost-effectiveness (Fraas and Munley 1989) and on enforcement issues (Helland 1998).

[6] As a result of a 2005 screening-level analysis of discharges from categories with existing water discharge regulations, EPA determined that the Pulp, Paper, and Paperboard Point Source Category ranked higher than any other category in discharges of toxic and nonconventional pollutants. Because of these findings, EPA conducted a more detailed study of this category with the primary purpose of determining whether the agency should revise the existing categorical effluent limitations guidelines and pretreatment standards (ELGs) (EPA 2006).

[7] PCS is a database created by EPA to track permit, compliance, and enforcement status of facilities regulated by the National Pollutant Discharge Elimination System (NPDES) program under the Clean Water Act.

[8] EPA did not have actual discharge data for BAT plants in the years prior to the 1998 Cluster Rule. In the absence of discharge data, EPA modeled baseline discharges based on available information on pulp production and bleaching processes in use in 1995. The number of mills reporting chloroform discharges in PCS varied from 13 in 2001 to 29 in 2004 out of a total of 78 mills subject to the 1998 Cluster Rule BAT limits still operating in 2004 (EPA 2006).

[9] Adsorbable organic halides (AOX) is a measure of the total mass of chlorinated organic matter in water and wastewater.

[10] EPA suggests that changes in production or bleaching processes could increase AOX loadings. Thus, for example, AOX loadings could increase with a shift from a softwood/hardwood mix to 100% softwood. The number of mills reporting AOX discharges in PCS varied from 27 in 2001 to 38 in 2004 (EPA 2006).

EPA recently completed a retrospective cost study of its 1998 Pulp and Paper Cluster Rule, which concludes:

> Our findings suggest EPA's ex ante cost estimates overstated the costs of both the Cluster Rule and the MACT II rule. Using publicly available data from NCASI, we found that EPA overestimated the capital cost of the Cluster Rule by 30 to 100 percent, depending on the choice of baseline year from which we derived the incremental cost. Among the reasons for EPA's overestimates of these capital costs are the mills' use of the clean condensate alternative (CCA) , flexible compliance options, extended compliance schedules, site-specific rules, use of equivalent-by-permit, and equipment/mill shutdowns and consolidations. However, the lack of detail in the available data means we can only speculate on which reason(s) is primarily responsible for EPA's overestimate (2014, 52).

As part of RFF's Regulatory Performance Initiative, Gray and Shadbegian (2015) examine the effects of EPA's 1998 Cluster Rule on the toxic releases from pulp and paper mills. Much of their paper focuses on air releases.[11] However, they report that BAT plants achieved a 96% reduction in chloroform releases in water, exceeding EPA's ex ante projection of an 85% reduction (63 FR 18575).

There is an additional literature on the environmental performance of manufacturing plants in terms of conventional air and water pollutants. Some of these studies have focused on the effects of EPA, state, and local enforcement of water rules (e.g., Magat and Viscusi 1990; Shimshack and Ward 2005). Shadbegian and Gray (2006) find that plants in the pulp and paper, steel, and petroleum industries located in states that score higher on political support for environmental issues have lower water pollution discharges.

In addition to these few studies of EPA's regulation of water discharges, a variety of studies have been conducted of other EPA programs directed toward reducing releases of toxic pollutants into the environment—for example, the Toxics Release Inventory and EPA's voluntary programs such as the 33/50 Program and the Common Sense Initiative. However, for the most part, these studies have focused on air and waste releases, instead of water releases.

[11] In terms of air emissions, Gray and Shadbegian (2015) report that reductions in air toxics are smaller than projected by EPA. Evidence of reductions in VOC emissions is somewhat mixed, with OLS estimates similar in magnitude to the ex ante predictions and the FE estimates somewhat smaller; no significant impact is found on PM10 emissions.

1.2.1. EPA's Toxics Release Inventory (TRI) Program

There is a more extensive literature looking at the effects on toxic releases of EPA's Toxics Release Inventory (TRI) program. The TRI program provides annual data on toxic releases from reporting plants beginning in 1988. Reported TRI releases decreased by 37% in the first years of the program, from 1988 to 1993, but decreases in reported releases slowed to only a 10% reduction in the subsequent period, between 1993 and 1998 (Hamilton 2005).

A number of studies have examined the effects of the TRI program on toxic releases in the earliest years of the program. Hamilton (1995), Konar and Cohen (1997), and Khanna et al. (1998) report that in the initial years, firms reporting TRI releases incurred abnormal losses in stock value. Konar and Cohen (1997) and Khanna et al. (1998) note that these losses in turn resulted in subsequent reductions in on-site toxic releases over the period 1990–1994.

However, Hamilton (2005, 250) concludes that given the current state of research, "one cannot say what fraction of reported reductions in TRI arose from the provision of information rather than from other factors, such as command-and-control regulation or market-related fluctuations in production." Other studies appear to support this conclusion. Konar and Cohen (1997) report that they were unable to find any evidence that firms receiving significant negative media attention with respect to their TRI releases reduced their emissions more than other firms of similar size. Kraft et al. (2011, 55) conclude that "the evidence indicates that community pressure does not seem to be a driving force behind chemical management decisions. Rather regulation and concern about potential financial liability more strongly affect corporate decisions about chemical management."[12]

Overall, the largest direct effect of TRI on emissions is likely to have occurred—if at all—only in the first few years of the TRI program, and it affected only the largest-emitting firms. Thus we believe that the "announcement effect" of TRI had largely dissipated in the period of interest for our retrospective study.

[12] Kraft et al. (2011) report that relatively few people and community groups appear to make direct use of the TRI data. Further, they state that media attention to the annual TRI release dropped off sharply after the early reports of the 1980s and early 1990s. Similarly, Hamilton (2005) reports that a 1991 GAO study and a later paper by Atlas, Vasu, and Dimock both found that most of the population "remains rationally ignorant about the TRI data" and does not seek out the data.

1.2.2. EPA's Voluntary 33/50 Program

EPA also sponsored the voluntary 33/50 Program to promote reductions in the releases of 17 target chemicals in the early 1990s.[13] The goal of the program was to reduce the total amount of these 17 chemicals released into the environment and transferred off-site by 33% by the end of 1992 and 50% by the end of 1995. EPA adopted the program because it was seeking quick reductions through a voluntary effort without relying on regulatory requirements. Through this program, EPA sought to encourage industry to develop pollution prevention practices and seek continuous environmental improvement even beyond the targeted reductions and chemicals (EPA 1991).

EPA (1999) reports the following key findings for its 33/50 Program:

- The program achieved its goal by 1994, one year ahead of schedule, primarily through program participants' efforts. Although the largest reductions in 33/50 Program chemicals reflected US action to phase out ozone-depleting chemicals under the Montreal Protocol, facilities also reduced releases and transfers of the other 33/50 chemicals by 50% from 1988 to 1995.[14]
- Facilities reported more source reduction activity (pollution prevention) for 33/50 chemicals than for other TRI chemicals, and this activity covered a greater percentage of production-related waste for 33/50 chemicals than for other TRI chemicals.
- Reductions continued at a higher rate for 33/50 chemicals than for other TRI chemicals in the year after the 33/50 Program ended.

Khanna and Damon (1999) offer support for EPA's finding, reporting that the program achieved the expected reduction in emissions by participating chemical firms over its initial three years (1991–1993). Other studies of the 33/50 Program yield a mixed picture. Innes and Sam (2008), Sam et al. (2009), and Bi and Khanna (2012) also find that the 33/50 Program was

[13] These 17 chemicals were selected because they were deemed to be high-volume, toxic chemicals with feasible control costs.

[14] Gamper-Rabindran (2006) also reports that the mandatory phase-out of two ozone depleting chemicals (out of 17 targeted chemicals) accounted for a significant fraction of 33/50 Program reductions. Additionally, she finds that for most industries, there was little difference between participants and nonparticipants in the reduction in health-indexed emissions of target chemicals.

effective in achieving additional reductions in emissions.[15] However, Gamper-Rabindran (2006) reports that 33/50 participants from only some sectors achieved additional reductions under the program. Innes and Sam (2008) and Bi and Khanna (2012) find that the 33/50 Program achieved the reductions in the early years of the program (with the strongest effect in 1992), but that participating firms did not achieve significant additional reductions after the program ended.

Further, Khanna and Vidovic (2001) and Vidovic and Khanna (2012) have reached the even stronger conclusion that the 33/50 Program had little overall effect on emissions. For example, Vidovic and Khanna (2012) suggest that participating facilities would have reduced emissions of the targeted chemicals anyway, for reasons not directly related to the 33/50 Program. They note that the TRI program and the Chemical Manufacturers Association voluntary Responsible Care program—launched two years before the 33/50 Program—may have already propelled participating firms on a path of reduction in their toxic releases.

In our view, to the extent that the 33/50 Program affected plant behavior, it affected emissions behavior primarily in the years before 1995.

1.2.3. Other EPA Voluntary Programs

In the wake of the 33/50 Program, EPA has also launched a number of other voluntary programs to encourage firms to take environmentally beneficial steps beyond the requirements mandated by regulation. In the period of interest to us (1995–2001), these voluntary programs include the Common Sense Initiative (1994–1998), Project XL (1995–2003), and National Environmental Performance Track (2000–2009). The assessment by Coglianese and Nash (2014) and Coglianese and Allen (2003) of these programs is that they did not yield significant environmental improvements.[16]

The Common Sense Initiative (CSI) focused on six industries. Coglianese and Allen (2003) report that three-quarters of the CSI projects were directed toward research or educational

[15] Sam et al. (2009) report that participating firms continued to achieve further reductions after the program ended.

[16] EPA's inspector general (IG) reports a similar conclusion with respect to EPA's Performance Track program: "EPA cannot tell if facilities made overall environmental improvements, or rather improved in one area and faltered in others" (2007, 20).

outreach, with no direct effect on environmental releases.[17] Only 10% of the projects were completed, and only four of these projects involved rule changes. None of the rules involved the pulp and paper industry. Coglianese and Allen conclude that "CSI was generally tall on ambition but short on meaningful and measurable accomplishment" (2003, 7–8).

Project XL succeeded in recruiting only a small number of firms—roughly 50—and according to Coglianese and Nash (2014), it "lost steam" within a few years of starting operation, falling far short of its goals.

Performance Track was just getting started at the end of the period covered by this study.[18] The program offered participating firms some form of regulatory relief—for example, a reduction in certain regulatory requirements and lower priority for routine inspections—and public recognition from EPA.[19] In turn, participating firms needed to achieve specific environmental goals (self-identified by the firm) beyond existing regulatory requirements and maintain a relatively clean record of compliance with existing regulatory standards. In its 2007 report, EPA's IG notes that while many members outperformed their sector, "Performance Track does not know if its members are 'top performers,'" and "we also found member facilities with more compliance problems or more toxic releases than their sector averages" (26–27). Coglianese and Nash (2014, 1) conclude that "facilities participating in Performance Track simply could not be shown to be top performers. Rather, what most distinguished these participants was a factor distinct from environmental quality, namely their propensity to engage in outreach with government and community groups."

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[17] The Strategic Goals Program (SGP) for the metal finishing industry—an often cited offshoot from the Common Sense Initiative—sought to promote less costly, innovative ways to reduce pollution releases through a voluntary, flexible approach. This voluntary effort was coupled with the threat of potential regulation through the effluent guidelines program. Brouhle et al. (2009) find that the pollution behavior of both participants in the SGP and non-participants was strongly correlated with the threat of regulatory action. They reported that SGP participants achieved little additional emission reduction beyond that of non-participants over the full study period. However, they found SGP participants did achieve larger emission reductions than non-participants in later years of the program—and suggest that participants were able to make further reductions in the later years of the program with the flexibility and Information exchange provided by the SGP.

[18] The initial group of participating facilities was selected by the end of 2000, and the first progress report on Performance Track gave results for 2003 (Coglianese and Nash 2014).

[19] Performance Track was terminated by the Obama administration on May 14, 2009. Just prior to her nomination as EPA administrator by President Obama, Lisa Jackson characterized Performance Track in a Philadelphia Inquirer story as "just one of those window-dressing programs that has little value" (Coglianese and Nash 2014, 8).

1.2.4. State Programs

States have also pursued more stringent command-and-control regulation as well as other, more voluntary approaches to the management of toxic chemicals over this period.[20] However, state programs differ substantially in terms of their stringency and effectiveness. Generally, states in the Northeast and on the West Coast adopted more effective toxics programs.[21]

Bui (2005) finds that refineries in states with more stringent toxics regulation had lower levels of air emissions than refineries in states with less stringent air pollution requirements. Bui also reports, though, that reductions in toxic emissions intensity were closely related to traditional command-and-control regulation of nontoxic conventional air pollutants.[22]

Bui and Kapon (2012, 43) find "strong evidence that both Federal and State P2 programs have led to significant reductions in average facility-level toxic releases." They also report the following:

- Facility-level responses to P2 programs differ across P2 program type; industry-specific technical assistance programs are consistently effective.
- Spillovers from information-based P2 programs operating through industry networks appear to play an important role in the success of these programs.

Finally, Shadbegian and Gray (2006) have also found that more stringent local regulatory requirements can result in lower emissions.

1.3. Scope of Study: Water Toxics

We originally intended to review EPA's initial round of BAT rules limiting toxic discharges to water as required by the 1977 CWA Amendments. This first round of standards—issued in the 1980s—addressed the toxics in water discharges from 24 primary manufacturing

[20] For example, 27 states had these programs in place by 1990; 48 states had programs in place by mid-1991. Thus these programs were in place before the period covered by this study (Bui and Kapon 2012).

[21] Kraft et al. (2011) rank states in terms of the proportion of firms achieving a reduction in toxic chemical releases and in population exposure risk over the period 1991–1995. On the basis of their ranking, for example, California was sixth in the nation. Kraft et al. also report that "all of the northeastern states fell within the top two tiers of state industrial environmental performance" (96). Of the 14 states identified by Bennear (2007) as adopting management-based regulations, 8 were located in the Northeast or on the West Coast.

[22] Bui (2005) did not address the effects of the 1995 MACT rule limiting toxic air emissions from petroleum refineries.

industries identified in the development of the amendments. EPA set more stringent BAT standards for toxics pollutants for 16 of the 24 industries that required additional control beyond the existing 1970s-era BPT-level standards for conventional pollutants such as biological oxygen demand.[23]

Preliminary discussions with EPA staff indicated that water discharge data would be available for these industries. Unfortunately, the tapes with backup data from the 1980s were inadvertently wiped out, so no data are available for this decade. As a result, we focused our study on the effect of EPA's water toxics rules for the pulp and paper industry. This BAT rule was issued in 1998 as part of the pulp and paper Cluster Rule.[24]

Section 304(m) of the 1987 CWA Amendments requires EPA to prepare a plan providing a schedule for review and revision of existing BAT rules.[25] EPA's first plan (January 1990) proposes a review of existing guidelines for the pulp and paper industry.[26] In listing pulp and paper mills, EPA cites a concern with the toxicity (and carcinogenicity) of the toxics discharged into water and the difficulty these discharges posed to permit writers in establishing discharge limits at individual plants.[27]

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[23] For an early assessment of EPA's standard-setting approach and ex ante cost-effectiveness analysis, see Fraas and Munley (1989).

[24] EPA also issued another Cluster Rule in 1998 addressing the air and water toxic releases of the pharmaceutical industry. We considered including plants from the pharmaceutical industry in our study but found that the available TRI data on water releases was limited to only a few plants. In addition to a small number of rules for plants in the manufacturing sector issued after 1990, EPA has also issued rules for additional source categories outside the traditional manufacturing sector. For example, EPA has issued effluent guidelines for construction and development, transportation equipment cleaning, landfills, and waste combustors and is currently developing coalbed methane extraction, shale gas, and dental amalgam effluent guidelines. http://water.epa.gov/scitech/wastetech/guide/industry.cfm.

[25] Section 304(m) also requires EPA to identify unregulated source categories discharging significant amounts of toxic pollutants and establish a schedule for setting guidelines for these sources.

[26] Organic chemicals, plastics, and synthetic fibers (OCPSF) and the pharmaceutical industry categories were also listed by the 304(m) plan. EPA was already under a court order to review and revise the OCPSF emissions guidelines. EPA issued BAT limits for OCPSF plants in 1987 and subsequently revised them in a succession of rulemakings arising out of litigation on the 1987 rule in the early 1990s (55 FR 97).

[27] 55 FR 93. Another key factor in EPA's decision to include this industry on the 304(m) list was that EPA was also subject to a consent agreement for the review of a guidelines rule limiting dioxin discharges from pulp and paper mills (absent a determination by EPA that such limits were not necessary). http://water.epa.gov/scitech/wastetech/guide/304m/archive/upload/2009_12_23_guide_304m_fr1990final.pdf.

In fact, EPA's interest in further regulation of pulp and paper plants already had a long history. Shortly after EPA issued its 1982 BAT limits, it discovered high levels of dioxin in fish in major rivers and the Great Lakes and linked dioxin (unexpectedly) to water discharges from pulp and paper mills. In 1988, in response to increasing pressure from environmental groups and a succession of lawsuits, EPA launched an interim strategy to address dioxin discharges by requiring states to develop water quality standards for dioxin (Hanmer 1988; see also Environment Reporter 1988). In turn, EPA expected that water quality standards adopted through the Section 304(l) process would drive discharge limits for individual pulp and paper mills. Houck (1991) reports that through this process, dioxin limits were proposed for 88 of 98 pulp and paper mills, and a number of pulp and paper mills had begun to convert to chlorine dioxide and hydrogen peroxide as bleaching agents, instead of using chlorine. By 1995, pulp and paper mills had realized a reduction of 70% in dioxin and furan discharges (See Table 1)—a reduction arguably driven by the Section 304(l) process (61 FR 36481).

Following EPA's listing of pulp and paper mills in January 1990, it agreed to a revised consent decree (*Environmental Defense Fund and National Wildlife Federation vs. Thomas*, D.D.C. No. 85-0973) requiring it to issue dioxin and furan BAT limits for bleaching pulp mills by June 17, 1995. Despite making its best efforts, however, EPA was not able to meet that date, and the final rule was delayed another three years. On April 15, 1998, EPA finally promulgated the pulp and paper Cluster Rule with final BAT effluent limits for 96 of the 104 mills covered by the consent decree (63 FR 18513).[28]

1.4. The Cluster Rule and BAT Rule for Pulp and Paper

1.4.1. The Cluster Rule for the Pulp and Paper Industry

In 1998, EPA issued joint rules limiting air toxics emissions under the National Emission Standards for Hazardous Air Pollutants (NESHAP) provisions of the Clean Air Act and effluent guideline limits for toxics in water for two subcategories of the pulp and paper industry (63 FR 18504). EPA adopted this joint rulemaking to allow industry to coordinate its air and water pollution control efforts and to provide industry with greater regulatory certainty.

[28] EPA promised to issue discharge limits for the remaining 8 plants in the dissolving kraft and dissolving sulfite subcategories as soon as possible.

1.4.2. The BAT Rule for the Pulp and Paper Industry

For bleached papergrade kraft and soda mills, EPA based BAT standards on elemental chlorine free (ECF) bleaching—the complete substitution of elemental chlorine with chlorine dioxide as a bleaching agent, the elimination of the use of hypochlorite, and the adoption of treatment practices to minimize the formation of dioxin and other chlorinated toxics.[29] EPA also considered but rejected two alternative, more stringent technology options for these mills: extended delignification (oxygen delignification and extended cooking of the pulp) and total chlorine free bleaching (63 FR 18542).[30]

The BAT limits and best management practices (BMP) for the bleached papergrade and papergrade sulfite subcategories were the only 1998 Cluster Rule requirements for direct dischargers in the pulp and paper industry (63 FR 18514).[31] EPA (2014) reports that no additional rules were issued for the pulp and paper industry between 1995 and 2001.

Based on these technology choices, EPA set BAT limits for dioxin and furans and for 12 chlorinated phenolic compounds,[32] for both the bleached papergrade kraft and soda subcategory (subcategory B) and the papergrade sulfite subcategory (subcategory E). In addition, EPA set BAT limits for AOX and chloroform discharges for mills in subcategory B. EPA also set AOX

[29] "Elemental chlorine free" describes a pulp bleaching process that does not use "elemental" chlorine gas, but this process still uses chlorine compounds, usually chlorine dioxide. Critics have argued that since some elemental chlorine is found with the chlorine dioxide process, chlorinated toxic by-products are reduced by ECF but are not eliminated (Reach for Unbleached Foundation 1999).

[30] For the smaller set of mills in the papergrade sulfite subcategory, EPA adopted elemental chlorine free bleaching technology as the basis for BAT for ammonium papergrade and specialty grade sulfite mills, and total chlorine free bleaching as the appropriate technology basis for BAT for calcium, magnesium, and sodium papergrade sulfite mills.

[31] Mills in these two subcategories were required to implement BMP to prevent or otherwise contain leaks and spills of spent pulping liquor, soap, and turpentine. Note that the 1998 rule did not revise the BPT or BCT limits for the industry (limits established in the earlier 1977 BPT and 1982 BAT rounds of regulation) (63 FR 18561).

[32] Pentachlorophenol and trichlorophenol are generated through bleaching processes using chlorine or chlorine-containing compounds and were among the 12 chlorophenols subject to the BAT limits under the 1998 rule. EPA expected that these compounds would be substantially reduced to below detection levels with changes in the bleach plant process. EPA also separately retained the 1982 limits for pentachlorophenol and trichlorophenol used as biocides. The 1982 BAT rule did not address the discharges of chlorophenolics associated with the bleaching process (47 FR 52013; 63 FR 18539).

limits for a subset of mills in subcategory E, but did not establish BAT chloroform limits for the subcategory E mills[33] (63 FR 18536–37).[34] (See Table 2.)

1.5. EPA Estimates of Benefits and Costs

1.5.1. Benefits

EPA notes that it was able to provide only partial benefits estimates for the pulp and paper rule. For example, EPA explains:

> EPA is not currently able to quantitatively evaluate all human health and ecosystem benefits associated with air and water quality improvements. EPA is even more limited in its ability to assign monetary values to these benefits. … The economic benefit values … should be considered a limited subset of the total benefits of this rule and should be evaluated along with descriptive assessments of benefits and the acknowledgment that even these may fall short of the real-world benefits that may result from this rule. (63 FR 18585)

Thus EPA did not estimate annual net benefits for its BAT standards, because so many categories of benefits are unmonetized that EPA believed the comparison would be misleading (63 FR 18590).

For the pulp and paper rule, the quantified and monetized benefits estimates ranged from $4 million to $41 million (63 FR 18590). This estimate was based on estimates of the reduction in cancer risks associated with fish consumption by subsistence and recreational fishermen, the

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[33] Adsorbable organic halides (AOX) is a measure of the total mass of chlorinated organic matter in water and wastewater (63 FR 18638). The adsorbable organic halides in pulp and paper wastewater include pentachlorophenol (PCP), 2,3,4,5-tetrachlorophenol (2,3,4,5-TeCP), 2,4,6-trichlorophenol (2,4,6-TCP),2,4-dichlorophenol (2,4-DCP), 2-chlorophenol (CP), and phenol. For subcategory E, AOX limits were set for mills in the calcium, magnesium, and sodium-based subset of the papergrade sulfite subcategory (63 FR 18537).

[34] In 1981, EPA submitted an affidavit under the authority of paragraph 8(a)(iii) of the Settlement Agreement, explaining that it had decided not to regulate 125 of the 129 listed toxic pollutants. EPA proposed BAT limits for four toxic pollutants: pentachlorophenol, trichlorophenol, chloroform, and zinc. After receiving comments for its proposed rule, EPA decided not to regulate chloroform. Only 9 mills (4.7% of existing direct discharging mills) were using closed biological treatment systems, which inhibit the volatilization of chloroform, and as a result, they were not meeting BAT-level chloroform standards. EPA judged that the required BAT-level reductions in chloroform discharges for these 9 mills could not be achieved without major modifications to their treatment systems and that these incremental reductions were not justified by the additional cost and non–water quality effects associated with such major modifications. EPA believed that the BPT-level biological treatment used by the remaining mills would be effective in controlling chloroform levels in water discharges (47 FR 52011).

increase in opportunities for recreational angling, and a reduction in sludge disposal costs (63 FR 18587).

EPA also provided a qualitative discussion of the water-related benefits, explaining:

> Toxic and nonconventional pollutants will be reduced to levels below those considered to impact biota in many receiving waters. Pollution reduction numbers are provided in Section VII.B.2. Such impacts include acute and chronic toxicity, sublethal effects on metabolic and reproductive functions, and loss of prey organisms. Chemical contamination of aquatic biota may also directly and indirectly impact local pescivorous wildlife and birds. (63 FR 18587)

EPA projected an expected reduction in toxic pollutant loadings from pulp and paper mills, ranging from 66% for adsorbable organic halides (AOX), to 70.5% for dioxin, to 80% for chloroform and chlorinated phenolics, and up to 93% for furans (63 FR 18545–46).[35] These reduction estimates—from a mid-1995 baseline—were developed using model plants to characterize pollutant loadings for a variety of pulping and bleaching processes, coupled with information on the specific pulping and bleaching processes and wastewater flow at each mill.[36]

1.5.2. Costs

EPA estimated that the water discharge limits for the pulp and paper rule would impose a pretax annualized cost of $247 million to $255 million per year (63 FR 18580). This estimate includes an annualized capital cost, operation and maintenance costs, and an "administrative cost" (a charge of 4% of capital costs) (63 FR 18579).

[35] EPA included in its estimates the projected reductions associated with pending projects that were not under construction by mid-1995; it excluded expected reductions where construction of control equipment and facilities were already under way by mid-1995 and any reductions from projects between 1992 and mid-1995. EPA estimates assumed that mills would continue to produce the same quantity and quality of pulp (63 FR 18544).

[36] In establishing the mid-1995 baseline, EPA updated its database using information provided in comments on the 1993 and 1996 notices of proposed rulemaking (NPRM), gathered by the American Forest & Paper Association (AF&PA) and National Council for Air and Stream Improvement (NCASI), available from public sources, and given in response to direct requests from individual mills (63 FR 18453). EPA reports that its 1995 baseline estimates of dioxin and furan loadings were comparable to NCASI's 1994 industry-wide estimates (61 FR 36841).

2. Methodology

2.1. Model

We used an approach similar to an event study approach, in that we are looking for a marked change in the toxic discharges between an ex ante period prior to EPA final rulemaking and the subsequent five-year period as mills came into compliance with their discharge limits. Under the CWA, the compliance deadline for dischargers was established through the permitting process. As a result, the compliance dates for pulp and paper mills were staggered over several years. For the pulp and paper industry, we aggregated emissions over a subset of HAP on the original TRI list (Table 3).

We used two different estimation methods to explore the effect of the Pulp and Paper Cluster Rule BAT limits on water discharges—a difference-in-difference method and OLS using first differences in toxic discharges. We considered the following basic model:

Y = f(P, EPA, LCV, C, XP)

For the difference-in-difference estimate, Y represents the level of discharge of toxic pollutants reported in the TRI database by each mill. We considered the reported annual discharges of toxic pollutants for the years 1995, 1997, 1999, 2001, and 2003. We used data only for these years because we found greater consistency in reporting (and a larger number of reporting plants) using TRI release data for the odd-numbered years.

For the first-difference approach, Y represents the change in emissions behavior over the ex ante, compliance, and ex post periods. We considered emissions behavior over four two-year periods: an ex ante period before the rule was issued (1995–1997), an early compliance period (EarlyCompliance) for the first two years in which the industry moved to comply with the rule (1997–1999), the last two years of the compliance period (Compliance) (1999–2001), and an ex post period after the required date for compliance (2001–2003).

The independent variables are as follows:

P = an index of production from the TRI data (described below) for the difference-in-difference model or the change in the TRI production index over the four periods for the first-difference model

EPA = dummy variable reflecting the US Northeast (EPA regions 1, 2, and 3, combined)

LCV = the League of Conservation Voters' score for the state where the plant was located

C = dummy variables for the compliance periods

XP = dummy variable for the ex post period

TRI Reported Production Index (P). Firms reporting to TRI also reported the change in production activity for the reporting year relative to the previous year. We used this information to construct a production activity index over the relevant period. The production index controls for changes in production activity over the several periods.

EPA Regional Variables (EPA). There may be regional differences in the starting point in terms of both the control in place and the stringency of plant effluent limits in the wake of the effluent guidelines rule. If plants already have controls in place because of existing regional action by EPA or the states in the EPA region, then we might expect a positive sign. If EPA or the states adopt more stringent limits in response to the rule, then we would expect a negative sign.

State Regulation (LCV). Several studies have reported that supplemental state regulation and voluntary programs achieved additional reductions in toxic releases beyond those required by EPA (see Bennear 2007; Bui and Kapon 2012). Shadbegian and Gray (2006) have also found that more stringent local regulatory requirements can result in lower releases. Gray and Shadbegian (2014) have used an index for states based on pro-environment voting behavior reported by the League of Conservation Voters (LCV). We have used their index and would expect the sign to be negative if these states are requiring additional reductions in toxic emissions. We used the LCV score for 1992 for the ex ante period, 1996 for the early compliance period, 1999 for the compliance period, and 2001 for the ex post period.

2.2. Data

We used the Toxics Release Inventory database for the years 1995 to 2005 to provide data on toxic discharges into water. The TRI dataset provides annual reporting of water toxic releases at the plant level. The original TRI chemical list contained roughly 300 individually listed chemicals, many of which are volatile organic compounds.[37] We focused on the water release data for a subset of toxic chemicals on the initial TRI chemical list (Table 3). For this subset of toxics, Table 4 presents the annual water discharges for the average plant.

[37] The TRI list of chemicals has been expanded over the years; in 1995, EPA added over 200 additional chemicals in its most substantial initiative. See http://iaspub.epa.gov/triexplorer/tri_text.list_chemical_new_95.

TRI required plants to report their releases where the amount of chemical used exceeded specified thresholds—for example, the threshold for use of the chemical in manufacturing and processing was 25,000 pounds per year.[38] In addition, TRI requires reporting only by facilities with 10 or more full-time employees (EPA 1998a).

In 1995, EPA adopted a short reporting form, the Alternate Threshold Certification Statement (Form A), for chemicals where the total release is less than 500 pounds and total manufacture, process, or “otherwise use” of the chemical is less than 1 million pounds (EPA 1998a). In using Form A, a plant certifies that its total annual release of the chemical does not exceed 500 pounds; as a result, Form A does not provide a specific amount of the release or apportion the release across media.[39]

TRI data has been used in a number of studies to evaluate the effects of the TRI initiative and other programs on toxics emissions behavior. However, even while relying on TRI data, these studies (e.g., Bui 2005; de Marchi and Hamilton 2006; Kraft et al. 2011) have recognized several concerns with the data, including the following:

- TRI release data is self-reported; generally the data are based on facility estimates (e.g., using engineering calculations), not on monitoring data.
- Reporting changes in 1991 triggered by the Pollution Prevention Act resulted in a substantial increase in reported releases in subsequent years.
- Changes occurred over this period in the listed chemicals and substances, with both additions and deletions to the list, especially the addition of over 200 chemicals in 1995.
- TRI reporting thresholds limit coverage to facilities with 10 or more full-time employees and to facilities with releases above specified thresholds for manufacture, process, or “otherwise use.”

[38] For facilities in the “Otherwise Use” category, the annual threshold was 10,000 pounds. There are also lower thresholds for certain chemicals known as persistent bioaccumulative toxins (PBTs), but reporting requirements at these lower thresholds for the PBT chemicals only began in 2000 (EPA 1998a).

[39] Total releases are measured by the amount released (air water and including disposed), treated, recycled, and burned for energy recovery at the facility and amounts transferred from the facility to off-site locations for the purposes of recycling, energy recovery, treatment, or disposal (EPA 1998a).

- The use of Form A beginning in 1995 reduced the availability of quantitative release reports for toxics released in amounts below the Form A thresholds.[40]

Finally, there are reasons to be concerned with the underreporting of releases in the TRI database. Tietenberg and Wheeler (1998) point out that "firms have incentives to mislead the public, either by overstating their environmental accomplishments or by selective omission (noting the positive outcomes and ignoring or burying the negative ones)." Surveys of reporting plants in the early years of TRI indicate that a significant fraction of reported reductions were a mixture of real and paper changes (Poje and Horwitz 1990). Dudley (1999) suggests that individual facility reports may contain such large errors that the data would be unreliable for site-specific analysis. On the other hand, EPA (1998c) reports that by the mid-1990s, over 80% of surveyed facilities used an appropriate method to estimate releases.

In addition to these concerns, we have found that only a limited number of plants in each of the covered industries consistently reported their releases to TRI. For example, in the case of chloroform, we found 23 plants reporting TRI releases in 1995. By 1998 and later reporting years, only 8 or 9 mills were reporting chloroform releases, and we found only four plants reporting consistently over the period from 1998 through 2003. The reporting thresholds and the introduction of Form A as of 1995 may account for the decline, and variability, in reported releases (see Snyder 2004).

To address this problem, we aggregated release data for a group of 27 toxics, a subset of the toxic chemicals on the initial TRI chemicals list. This subset included chlorine, chlorine dioxide, chloroform, phenols (including chlorophenols) and a number of VOCs.[41]

2.3. Defining a Baseline

Identification of a baseline is a critical element in evaluating the effect of these water toxics rules. The identification of an appropriate baseline was a controversial issue in EPA's recent retrospective cost study of the Pulp and Paper Cluster Rule. EPA adopted 1995 as a

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[40] Beginning in 1995, EPA allowed facilities to file a short form, Form A, if the chemical being reported is not a PBT chemical; the chemical has not been manufactured, processed, or otherwise used in excess of 1 million pounds; and the total annual waste management (i.e., releases including disposal, recycling, energy recovery, and treatment) of the chemical does not exceed 500 pounds (EPA 1998a).

[41] The BAT standards for chlorophenols were "no detect," so releases of chlorophenols would likely be below TRI reporting thresholds.

baseline for its retrospective study because it used 1995 as the baseline in its RIA for the Cluster Rule. At the same time, the pulp and paper industry has argued that it started the transition to elemental chlorine free bleaching technology before 1995—and that EPA's choice of a 1995 baseline significantly understated the total capital expenditures by the industry in reducing its toxic discharges.

Beginning with EPA's Section 304(l) guidance (finalized in 1989) requiring states to adopt water quality–based discharge limits, the pulp and paper industry faced regulatory requirements forcing a move away from elemental chlorine bleaching.[42] Through the Section 304(l) process, 36 states had adopted water quality criteria by mid-1991, and dioxin limits were proposed for 88 of 98 pulp and paper mills. As a result, a number of pulp and paper mills had begun to convert to chlorine dioxide and hydrogen peroxide as bleaching agents, instead of using chlorine (Houck 1991). By 1995, pulp and paper mills had realized a reduction of 70% in dioxin and furan discharges (61 FR 36481).[43] Thus the pulp and paper industry response was well under way by mid-1995, with significant reductions in toxic discharges prior to the promulgation of the 1998 Cluster Rule.

In our view, the industry toxic discharges in the 1995 to 1997 period provide an appropriate baseline for the Cluster Rule, instead of adopting some earlier baseline period that would include reductions driven by the earlier Section 304(l) initiative. Further, a 1995 baseline (and an ex ante baseline using 1995 to 1997) is consistent with the baseline adopted by EPA in the final Cluster Rule and in its recent retrospective study of the costs of the Cluster Rule.[44] Of course, plant investment to shift away from elemental chlorine bleaching triggered by the 304(l) process may have continued in the years after 1995. Thus it is difficult to determine whether

[42] Final guidance in June 1989 implementing Section 304(l) spelled out a timetable and process for compliance. This guidance is the extent to which EPA held the line on its proposed requirements and "aggressive" timetable. Under Section 304(l), EPA had the authority to review, independently, all three lists of waters, lists of sources, and the independent control strategy (ICS) for individual plants. Each ICS was a new individual permit with enforceable effluent limitations. Where the ICS was approved, the deadline for compliance was June 1992; where disapproved, an EPA-imposed ICS required compliance by June 1993 (Houck 1991).

[43] The pulp and paper industry estimated capital expenditures of $1.9 billion from 1988 to 1993 and another $450 million from 1993 to 1995. Private communication from Tim Hunt, Senior Director, Air Quality Programs, American Forest and Paper Association. July 28, 2015.

[44] Gray and Shadbegian (2015) also used 1995 as the baseline year for their retrospective study of the Pulp and Paper Cluster Rule.

reductions in toxic water discharges in the years after 1995 were the result of the Cluster Rule or of the earlier 304(l) initiative.

Finally, we compared the toxic water discharges of pulp and paper mills subject to the Cluster Rule BAT limits with the discharges of pulp and paper mills subject only to the Cluster Rule air toxics Maximum Achievable Control Technology Standards (MACT) limits. This pairing of bleached papergrade mills with other pulp and paper mills—regulated under the Cluster Rule for their air toxics emissions, but not for their water discharges—serves as a control for the variety of factors affecting the pulp and paper industry as a whole.

3. Model Results

Model 1: Difference-in-Difference for the Level of Discharges. The model results suggest little change in the level of toxic discharges for the mills in the sample over the period 1995–2003. The coefficients for the regulated mills in the control years (2001 and 2003) are small, negative, and not statistically significant. The level of production is positive and statistically significant; the LCV ranking is negative but not statistically significant. The R-squared is 0.137; the F-statistic is statistically significant at the 1% level.

Model 2: First Difference in the Change in Toxic Discharges. Again, the model results suggest little change in the level of toxic discharges over the compliance and ex post periods for the mills in the sample. The LCV coefficient and the coefficient for change in production are positive but not statistically significant. The R-squared is 0.04; the F-statistic is statistically significant at the 10% level.

Overall, our statistical analysis does not show a statistically significant reduction in toxic discharges into water relative to the control group.[45] (See Tables 5A & 5B) While there is some reduction in toxic discharges by the BAT-covered plants in the few years immediately after 1995, the mills in the MACT-only control group also reduced their water discharges over the 1995–2003 period. Thus our analysis does not show any statistically significant reductions for BAT-covered mills in the years after EPA issued its final rule in 1998.

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[45] Our measure of toxic discharges into water includes chlorine, chlorine dioxide, chloroform, chlorophenols, and a number of volatile organic compound hazardous air pollutants (VOC HAPs). Dioxin and furans were not included in this aggregated toxics measure because TRI facilities were not required to report dioxin releases until 2000. Chloroform is a relatively minor component in our aggregate measure and, for that matter, of the total toxic loadings in the water discharges of pulp and paper mills (EPA 2006).

Because the Cluster Rule BAT limits required a shift in the production process to elemental chlorine free bleaching, with attendant reductions in chloroform and chlorophenols, and because the MACT limits required a significant reduction in VOC HAPs (which are likely to volatilize to air from water discharges), one might expect that the Cluster Rule limits would have resulted in further reductions of toxic releases into water.

However, our results do not support a conclusion that bleached papergrade pulp and paper mills achieved any appreciable reduction in the discharge of these toxics into water in the years after the Cluster Rule was issued in 1998. This result is consistent with the history—as reported by Houck (1991)—that bleached papergrade Kraft and soda pulp and paper mills were already subject through the Section 304 (l) process to stringent water quality–based discharge limits and were taking action to achieve substantial reductions in their toxic water discharges prior to the mid-1995 baseline adopted by EPA in the Cluster Rule.[46] As additional support for this interpretation, EPA substantially scaled back its estimate of baseline dioxin and furan loadings over the course of its rulemaking. Thus, the mid-1995 baseline estimates for toxic discharges in the final rule are 70% to 80% below EPA's earlier estimates of discharges in 1992 (61 FR 36841)[47] (Table 1). The TRI data also show a marked decline from 1993 to 1995 in our aggregate measure of toxic discharges to water from the average mill.[48] (See Figure 1.)

Finally, Gray and Shadbegian (2015, 13) offer a similar report that "chloroform releases fell dramatically throughout the sample period, with much of the reduction happening in the

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[46] For example, Houck (1991) reports that through the Section 304(l) process, "dioxin limits were proposed for 88 of 98 pulp & paper mills and a number of pulp & paper mills had begun to convert to chlorine dioxide and hydrogen peroxide as bleaching agents, instead of using chlorine."

[47] Similarly, EPA's projection of mid-1995 baseline chlorinated phenolic compounds loading in the final Cluster Rule was more than an order of magnitude lower than its 1993 NPRM estimate for 1992, and the mid-1995 baseline AOX loadings were 25% lower than its 1993 estimate of 1992 loadings. EPA's 1993 NPRM estimate of baseline loadings was based on data "believed to be representative of the mill's operations as of January 1, 1993" (EPA 1993, 80) (58 FR 66078).

[48] EPA's 2006 report on the effects of the Cluster Rule appears to tell a somewhat different story, reporting a 97% to 99% reduction in chloroform discharges from EPA's calculated 1995 baseline for every year over the 1999–2004 period. However, even in 1999, immediately after EPA issued its final rule, the three reporting mills in that year already showed a 99% reduction from baseline (EPA 2006, Table 9-12). EPA's 2006 report also presented mixed results in terms of a reduction in AOX discharge: Table 9-14 shows a 69% reduction in normalized/process-related production for 2002, but again the 17 sources reporting in 1998 (the year EPA adopted the final Cluster Rule) were already achieving a 60% reduction in AOX discharges from the 1995 baseline. Further, Table 9-17 shows only a 30% reduction in 2002 and a 10% reduction in 2004 in total AOX loading from 1995 loadings. Our results are more consistent with the 10% to 30% estimate of the reduction in AOX discharges.

1990s, before the effective date of the Cluster Rule. … This is consistent with paper manufacturers taking steps during the 1990s including the installation of extending cooking techniques and oxygen delignification, to reduce their use of chlorine bleaching, even before the Cluster Rule took effect, with little additional reductions in later years."[49]

4. Concluding Discussion and Lessons

We set out with the objective of adding to our understanding of what technology-based standards actually accomplished. In addition, we believed that a retrospective study could offer lessons on ways to improve ex ante analysis of regulations and identify what might be done—better—in the future to conduct retrospective analyses.

In terms of conducting this retrospective study, it has been a surprise to find out that the existing data on releases of toxics into water over this period are so sparse. Because of the data limitations, we were able to conduct an analysis of only the Pulp and Paper Cluster Rule. Our evaluation suggests that the Pulp and Paper Cluster Rule yielded little or no additional reduction in toxic water discharges. There are two possible reasons. First, while EPA adopted a readjusted mid-1995 baseline for its final 1998 rule, the baseline estimates for mills continued to be based on calculations using model plants rather than monitoring data on actual discharges.[50] Actual discharges from mills in the mid-1995 period may well have been lower than calculated by EPA. Second, EPA's 1998 final rule also adopted a less expensive—and somewhat less stringent—BAT control technology option than originally proposed in 1993. The 1998 BAT effluent limits were based on elemental chlorine free processes but did not require oxygen delignification or

[49] EPA reports that chloroform discharges are closely correlated with the use of hypochlorite bleaching; elimination of hypochlorite bleaching can reduce chloroform discharges by two orders of magnitude. In this respect, changes in chloroform discharges could serve as a good measure for a shift away from the use of hypochlorite in the bleaching process. Chloroform discharges may also be related to chlorine dioxide bleaching and pulp production (67 FR 58990). Note that EPA's 2006 report and Gray and Shadbegian's (2015) results are also based on a relatively small number of BAT mills. EPA's 2006 report based the chloroform estimates on PCS data for 22 plants in 2002 and 29 plants in 2004. Gray and Shadbegian (2015, 18) report that "releases of chloroform are relatively rare, with only about half of the sample reporting any chloroform releases; this number shrank rapidly during the years between 1991 and 2009." (We found only eight or nine mills providing reports to TRI on chloroform releases to water after 1998.) In addition, in the absence of data on discharges, EPA's 2006 report based the chloroform reduction estimate on a calculated 1995 baseline for toxic discharges.

[50] EPA developed baseline estimates of pollutant loadings using model plants to characterize pollution loadings for a variety of pulping and bleaching processes, as well as information on the specific pulping and bleaching processes and wastewater flow at each mill.

extended cooking of the pulp.[51] It is our view that the standards largely served to ratify changes that the industry was already taking in response to EPA's Section 304(l) initiative in the late 1980s. EPA scaled back its water discharge requirements because the Cluster Rule also required further action by the pulp and paper industry to reduce air toxics emissions, with capital costs of $750 million and annualized costs of $150 million (63 FR 18549). Thus, in light of the accumulated record by the mid-1990s of the effectiveness of the switch to chlorine dioxide control technology in reducing toxic water discharges, EPA concluded that this technology represented the best technology among those considered (63 FR 18549) and adopted BAT limits that imposed water-related control costs on the laggards in the industry rather than add to the industry's overall cost burden.

As noted above, Gray and Shadbegian (2015, 144) report a sharp decline in chloroform releases "but the trend begins at the start of the pre-CR period, with a leveling out (at much lower levels) in the later period." We believe our results are generally consistent with this conclusion. While both of these papers rely on TRI data, they differ in terms of the time period and the pulp and paper mills covered in the sample. In addition, the two papers use different measures of toxic pollutants: Gray and Shadbegian focus on chloroform, while our report uses an aggregation of 27 toxic pollutants discharged by pulp and paper mills. Both papers recognize that over the course of rule development, EPA had to modify the estimates of pollution reduction and costs of the rule to reflect the changing baseline; we may differ only in terms of the emphasis placed on EPA's Section 304(l) process in driving these early reductions. Finally, Gray and Shadbegian (2015, 18) suggest that even if the Cluster Rule largely just addressed the water discharges of the laggards in the industry, it was still important to do so because "failing to pressure those laggards might have adverse consequences for compliance with future regulations." Thus if the laggards were not brought up to a BAT level, a future rule would have to confront a laggard set of sources in determining the best available technology economically achievable—with an emphasis on "economically achievable." Others might argue that a rule addressing the laggards was necessary in order to level the playing field for competitors. On the other hand, the benefits of reducing the discharges from these mills may not justify the additional cost of control (e.g., because of the location of the mill). EPA's analysis does not break down

[51] EPA estimates that the capital cost for the selected BAT option (conventional pulping) would be on the order of $1 billion, while the addition of oxygen delignification or extended cooking as proposed in 1993 would have doubled the capital cost (63 FR 18544).

benefits and costs in a way that allows a further judgment on the merits of setting BAT limits for these two subcategories.[52] A more complete economic analysis would provide a breakdown of the benefits and costs for the affected plants covered by the rule.

Finally, our result—the Cluster Rule's water discharge limits yielded little or no additional reduction in toxic discharges as compared to the rest of the industry—represents an important complement to our findings with respect to the Cluster Rule effect on air toxic emissions. It also represents an important complement to the conclusion in EPA's recent retrospective cost study that ex ante cost estimates overstated the capital cost of the Cluster Rule by 30 percent to 100 percent (EPA 2014).

However, these results are limited by the small number of BAT mills in the sample—20 to 22 mills out of a total of 78 operating in 2004 (we were able to obtain TRI data for water releases for 76 MACT-only pulp and paper mills to serve as a control). We believe that the TRI reporting thresholds likely limited the number of plants reporting quantitative estimates of toxic discharges to TRI in the pulp and paper category. In addition, other factors not accounted for in the models may in fact be important in explaining the emissions behavior in the compliance and ex post periods. It would be helpful to have a dataset that combines emissions data with data on plant operations; for example, emissions data could be combined with plant-level data from the Census Bureau. Although there is no obvious bias, we are concerned that the reporting BAT plants in our sample may not be representative of the industry. Thus we believe that such results should be viewed as preliminary and deserving of further study.

To facilitate a retrospective analysis, EPA should provide in the final rule for the collection of data on the control measures adopted and the costs incurred to comply with the rule, as well as plant production characteristics for at least a representative sample of plants. One way of doing this would be to require the reporting of this information to EPA as part of the final rule. However, the collection of information required would be extensive and costly, even if restricted to a representative sample of covered plants, so EPA would need to be strategic in its selection of retrospective studies. EPA may be able to reduce the burden of retrospective studies further by coordinating its study with existing data collection by the Census Bureau.

[52] EPA's analysis does yield an annualized cost estimate for BAT (and pretreatment standards) of $263 million and a benefits estimate of $12 million to $57 million. EPA cautions that its monetized benefits estimate is incomplete (63 FR 18587–90).

In order to conduct such information collection, EPA would have to provide funding to support the study. Such a project would face significant competition from other EPA initiatives in a period of tight budgets. It also would require Office of Information and Regulatory Affairs (OIRA) approval under the Paperwork Reduction Act (PRA).[53] To obtain OIRA approval, EPA would have to show that the collection has "practical utility" and is the least burdensome way of obtaining the information. The PRA also requires the agency to go through a public comment process.

OIRA (2010b) has moved to streamline its PRA review process by establishing a generic clearance process for specific types of information collection. In a memo titled "Facilitating Scientific Research by Streamlining the Paperwork Reduction Act Process," OIRA (2010a) has outlined options and strategies for agencies to use to streamline the process of getting OMB approval of research-related information collection. We recommend that OIRA explicitly provide this streamlined PRA process for studies that collect data for retrospective studies.

In addition, in its review of agency rules under EO 13563, OIRA should ensure that agencies establish in the rule a process for ex post evaluations of the effectiveness of its most important rulemakings. To implement this recommendation, OIRA could issue guidance identifying factors agencies should consider in selecting rules for regulatory review, the kinds of measurable outcomes targeted in the analysis, the associated data requirements, the type of analysis that will be used, and the timeframe to be evaluated. OIRA has already provided some general guidance along these lines. In a memorandum titled "Executive Order 13563: 'Improving Regulation and Regulatory Review'" (OIRA 2011a), OIRA identified the following topics as areas that agencies should address in conducting retrospective review: public participation, prioritization, analysis of costs and benefits, and coordination with other forms of mandated retrospective analysis and review.[54] OIRA should elaborate further in additional guidance to the agencies on these key elements.[55]

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[53] OIRA is part of the Office of Management and Budget in the executive office of the president.

[54] In an additional memorandum titled "Retrospective Analysis of Existing Significant Regulations" (OIRAb), OIRA also recommended that to promote a consistent culture of retrospective review: "…future regulations should be designed and written in ways that facilitate evaluation of their consequences and thus promote retrospective analyses. To the extent consistent with law, agencies should give careful consideration to how best to promote empirical testing of the effects of rules both in advance and retrospectively."

[55] Aldy (2014) reviews the federal governemnt experience with retrospective review and offers a set of recommendations to enhance the role of retrospective analysis in improving Federal regulation.

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Tables and Figures

Table 1. EPA Estimates of Baseline Discharges and Projected Reductions in Discharges

Pollutant	1992 discharge (g/yr)	1995 discharge (g/yr)	EPA estimated reduction from 1995
Dioxin	70	16	12
Furan	341	122	113

Source: EPA 1996, 1998b

Table 2. EPA-Established BAT Standards by Pollutant for the Two Regulated Subcategories[56]

	Bleached papergrade kraft and soda mills (subcategory B)	Papergrade sulfite: calcium, magnesium, sodium (subcategory E)	Papergrade sulfite: ammonium and specialty (subcategory E)
Technology basis	Elemental chlorine free	Total chlorine free	Elemental chlorine free
Dioxin and furans	BAT	Not regulated[a]	BAT
12 chlorinated phenolics	BAT	Not regulated	BAT
Chloroform	BAT	Not regulated	Reserved
AOX	BAT	BAT	Reserved

Source: EPA 2006

[a] Mills with total chlorine free technology will not discharge dioxin/furans, chloroform, and chlorinated phenolics; as a result, EPA did not set discharge standards for these papergrade sulfite mills.

[56] At promulgation (1998), there were 84 mills in the bleached papergrade kraft and soda subcategory and 11 mills in the papergrade sulfite subcategory (EPA 2006). EPA did not establish BAT limits for subcategories A, C, D, F, G, H, I, J, K, and L.

Table 3. Toxics in Water Discharges

ACETALDEHYDE ACROLEIN CRESOL (MIXED ISOMERS) CUMENE FORMALDEHYDE M-CRESOL METHANOL	M-XYLENE O-CRESOL O-XYLENE P-CRESOL PHENOL P-XYLENE XYLENE (MIXED ISOMERS)	CHLORINE DIOXIDE CHLOROFORM CHLORINE ACETONE CATECHOL METHYL ETHYL KETONE BENZO(G,H,I)PERYLENE	ETHYLENE GLYCOL CERTAIN GLYCOL ETHERS BIPHENYL CHLOROMETHANE DICHLOROMETHANE TRICHLOROETHYLENE

Table 4. Average Plant Discharges (pounds per year)

	N	1993	1995	1997	1999	2001	2003	2005
MACT only	68	16,090	50,655	34,115	16,171	10,411	11,414	42,513
BAT + MACT	20	126,841	28,830	34,236	9,161	5,610	15,033	11,942

Table 5-A. Difference-in-Difference for Pulp and Paper Mills

Independent variable	Emissions diff-in-diff
Production	44,842***
	(17,262)
Year 1997	–11,227
	(6,507)
Year 1999	–30,202
	(10,799)
Year 2001	–18,460
	(15,446)
Year 2003	–20,479
	(15,452)
BATeff:1997	–2,012
	(10,285)
BATeff:1999	597
	(11,431)
BATeff:2001	–17,014
	(15,781)
BATeff:2003	–12,653
	(15,775)
R-squared	**0.137**
F statistic	**6.08*** **
N, MACT only	**76**
N, BAT + MACT	**22**

Note: t-statistics in parentheses (*=p<0.10, **=p<0.05, ***=p<0.01).

Table 5-B. First Difference/OLS for Pulp and Paper

	Change in emissions/OLS
Change production	10,249
	(20,958)
LCV	76
	(150)
Early compliance	–5,574
	(7,188)
Compliance	7,855
	(7,687)
Ex post	14,546*
	(7,826)
Treatment	10,637
	(8,635)
Early compliance: BAT	–30,247
	(20,964)
Compliance: BAT	–7,724
	(14,850)–2,446
Ex post: BAT	
	(14,615)
Constant	–17,341**
	(8,140)
R-squared	0.042
F statistic	1.66
N, MACT only	68
N, BAT + MACT	20

Note: t-statistics in parentheses (*=p<0.10, **=p<0.05, ***=p<0.01).

Figure 1. Average Plant Toxic Loadings in Discharges to Water (pounds per year)