Is there Life after Death?: The Enduring Effects of the 33/50 Program on Emission Reductions

Phi Cong Hoang
Doctoral Student
Terry College of Business
University of Georgia
phihoang@uga.edu

William McGuire
Assistant Professor of Economics
University of Washington, Tacoma
wmcguire@uw.edu

Aseem Prakash
Professor, Department of Political Science
Walker Family Professor for the College of Arts and Sciences
Founding Director, UW Center for Environmental Politics
University of Washington, Seattle
aseem@uw.edu

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Abstract

Do voluntary environmental programs (VEPs) influence firms' environmental performance even after they have been discontinued? We examine the U.S. EPA's 33/50 program that was launched in 1991 and discontinued in 1995. With 1988 as the baseline, 33/50 participants pledged to reduce the discharges of 17 toxic chemicals (a subset of chemicals listed under the Toxics Release Inventory (TRI) program) by 33% by 1992 and by 50% by 1995. To explore whether 33/50 participants reduced the discharges of the targeted chemicals after 1995, we examine a panel of approximately 20,000 facilities listed under SIC codes 20-39. Starting with a difference-in-difference specification, we employ a range of estimators to identify the causal effect of participation in the 33/50 program on toxicity weighted releases of 33/50 chemicals during the life of the program, and in two subsequent periods, 1996-2004, and 2005-2013. Our results indicate that participating firms reduced emissions by as much as 66% during the program's life, and by an additional 20-30% after the program had ended (1996-2013). Furthermore, 33/50 participation appears to have "spilled over" into reduced emissions of non-33/50 TRI chemicals (579 in all). Participating firms reduced toxicity-weighted non-33/50 emissions by as much as 27% during the life of the program (1992-1995), and continued to make even deeper cuts in emissions (up to 60%) in the periods following the end of the program (1996-2013). To explore mechanisms leading to these pollution reductions, we then examine how 33/50 participation influenced firms' environmental innovations as reflected in Source Reduction Activities (SRAs). We find that participants adopted more SRAs than non-participants during and after 33/50, although this effect appears to "decay" as we examine periods further from the beginning of the program.

Introduction

Voluntary environmental programs (VEPs) are important policy instruments for motivating participating firms to reduce their pollution levels beyond the mandatory legal requirements. In this paper, we examine the U.S. Environmental Protection Agency's (EPA) 33/50 program that was launched in 1991 and discontinued in 1995. Firms participating in 33/50 pledged to reduce the discharges of 17 highly-toxic chemicals listed (a subset of chemicals listed under the Toxics Release Inventory Program, TRI), aiming for a 33% reduction by the end of 1992 and a 50% reduction by the end of 1995 (USEPA, 1992; 1997). We pose two questions: (1) Did 33/50 participants reduce the discharges of the 17 targeted chemicals after 1995? (2) Did these discharge reductions spill over to TRI chemicals not covered by 33/50?

Scholars debate the efficacy of VEPs in reducing participants' pollution levels during the programs' life span but few have looked at their effectiveness once the program has been discontinued. What if, to fulfill program requirements, participating firms adopt new technologies and implement enduring changes in management practices and organizational culture? If so, it's plausible that the effect of program participation on pollution discharges would be observed even after the program was discontinued. In examining this question, we speak to the broader theoretical issue of how institutional legacies influence firms' environmental performance.

Scholars have examined the impact of institutional legacies in a variety of contexts (Thelen, 1999). Acemogolu et al. (2001) showed the effects of colonial legacies on economic performance of former colonies. The Soviet legacy literature (Brubaker, 1994; Glen, 1999) documents the enduring effects of the communist system on the political, social and economic life of post-communist Eastern and Central European countries (Crowley, 2004). Affirmative action policies across the world seek to correct structural inequalities that continue despite the death of the institutions that created them (Young, 2001). While scholars have examined the role of institutional legacies in shaping firms' policies across issue areas (Hannan and Freeman, 1984; Gertler, 2001; Morgan and Quack, 2005), including corporate social responsibility (Matten and Moon, 2008), very few studies have systematically explored the institutional legacy argument in the context of firm-level environmental policies.

The 33/50 program was among the earliest VEPs established by an environmental regulatory agency anywhere in the world. Unlike typical governmental regulations, firms' participation in the 33/50 program was voluntary. The EPA assured the invited firms that they would not be penalized for either failing to join the program, or, if they decided to join, failing to meet the program goals (USEPA, 1992). Given its experimental nature, the EPA decided to limit its time span: it was discontinued in 1995 and the EPA declared that this program met the stated goals of pollution reduction (USEPA, 1997).

33/50 sought to encourage continuous improvement via environmental innovation. We suggest that this is where one might locate an important mechanism for the programs' institutional legacy. Firms typically do not "switch on" and "switch off" their innovation processes that lead to pollution reduction. Innovation requires substantial investments in new technologies, inputs, management systems, and organizational culture. Consequently, innovation processes take time to implement and become institutionalized (Watkins and Marsick, 1993). Arguably, this makes it less plausible for firms to establish an internal innovation infrastructure that has a legacy effects in a short time period. Recall the life span of 33/50 was only 3 years (1992-1995). Thus even if 33/50 was able to induce internal innovation processes among participating firms, skeptics might wonder about the longevity of such internal changes. Viewed this way, the 33/50 program becomes a "hard case" (Bennet and Elman, 2007) to explore whether innovation processes can be jump-started in a short time period, and the extent to which, once instituted, such processes continue even in the absence of the impetus that initiated them.

Bi and Khanna (2012) have examined how 33/50 participation influenced participants' environmental performance during the 1996-1998 time period. We build on this important study in four ways. First we assess the effect of 33/50 participation on discharges of the 17 targeted chemicals for an extended time period once the program was discontinued, 1996-2013. Second, we control for an important alternative mechanism that might drive pollution reductions: membership in the Responsible Care VEP, which is the flagship VEP for the chemical industry (specifically, SIC codes, 20-39). Third, we expand the scope of our study to examine the effect of 33/50 participation on the discharges of TRI chemicals *not* targeted by the 33/50 program – after all, environmental innovation targeting 33/50 chemicals might have spilled-over to non-targeted chemicals, as well. Fourth, to explore an important mechanism through which firms can reduce emissions, we examine how 33/50 participation affected firms' adoption of important environmental innovations. Firms can reduce pollution via "ex ante activities" such as technological innovations that reduce the creation of pollution, as well as "ex post" or end-of pipe activities such as recycling, treating, and energy recovering that treat pollution before it is discharged (Dutt and King, 2014). The focus of 33/50 was on the former. Carmen, Innes, and Sam (2013) report that 33/50 participation depressed innovation as reflected in patent filing after 1995. However, we study how 33/50 membership encouraged both patented as well as non-patented innovations as reflected in plants' source reduction activities (SRAs).

Empirically, we confirm previous findings that 33/50 reduced emissions of targeted chemicals during the life of the program (1991-1995). We also provide evidence that emissions reductions continued beyond the life of the program (1996-2013), resulting in additional reductions of 20-30% after the program ended. Furthermore, we show that 33/50 participation reduced emissions of *non*-33/50 TRI chemicals by as much as 27% during the life of the program, and led to additional reductions of up to 60% in the subsequent periods. Our analysis of environmental innovations shows that participating firms adopted more SRAs than non-participants during and after 33/50's life span, although this effect appears to "decay" in the years after the program ended.

The paper is organized in seven sections. In section two, we review the literature on on why firms join VEPs, and after joining, whether they pollute less. In the third section, we describe the 33/50 program, discuss why firms join 33/50 and how 33/50 participation correlates with environmental performance. The fourth section outlines the model, variables, and empirical methods. We present our model findings in section five. In section six, we provide an extension to the paper by examining how 33/50 participation affects firm-level innovation. We conclude in section seven.

VEPs and Pollution Reduction

VEPs have proliferated across countries and sectors. Some of the prominent ones include Energy Star, Responsible Care, Forest Stewardship Council, and ISO 14001. These programs have been established by industry associations, NGOs, regulators, international organizations, as well as various multi-stakeholder partnerships. Trade associations have sponsored programs such as Responsible Care (chemical industry), the Sustainable Forestry Initiative (the forestry industry), Sustainable Slopes program (the ski industry), and the Strategic Goals Program (the metal-finishing industry). These industry-specific programs allow firms to collectively safeguard their environmental reputations (Barnett and King 2008; Prakash and Potoski, 2007). Importantly, recognizing that an environmental accident in one firm can create negative reputational spillovers across the industry, these programs seek to diffuse best environmental practices to signal the industry's commitment to environmental protection along with reducing the risks of environmental mishaps that results from the lack of due diligence.

In addition to trade associations, VEPs have been sponsored by NGOs. These initiatives reflect NGOs' frustration with existing regulations that they assess as lax or outdated. Scholars note gridlock in Washington, D.C. has made it impossible to pass new federal environmental regulations since the 1990s (Klyza and Sousa, 2008). Enforcement shortfalls have motivated NGOs to establish VEPs in sectors such as forestry. NGOs political strategy has been to target key firms with the hope that these firms will persuade their suppliers located abroad to join VEPs.

Governments/regulators have also sponsored VEPs (Fiorino, 2006; Coglianese and Nash, 2009). This again, ironically, is rooted in governments' inability to amend existing regulations or enact new ones in response to environmental challenges. The 33/50 program is an example of a government-sponsored VEP. The US EPA has been at the forefront of sponsoring VEPs, with more than 60 to date.

Some other notable VEPs are multi-stakeholder initiatives jointly established by governments, firms, and NGOs. Such was the case for the Roundtable on Sustainable Palm Oil (RSPO) which brought together the World Wildlife Fund, Golden Hope, the Malaysian Palm Oil Association, Sainsbury's and Unilever. Another example is the Marine Stewardship Council (MSC) that was established by the World Wildlife Federation and Unilever (Gulbrandsen, 2009; Fransen, 2012). The bottom line is that VEPs are an important and established feature of contemporary environmental governance, inducing firms to produce environmental public goods.

Yet, VEPs pose an interesting policy puzzle: why should firms incur private costs by joining VEPs that impose obligations not required by law? The literature suggests that firms join VEPs to credibly signal their commitment to environmental stewardship. Program participation serves as an environmental brand that allows external stakeholders to differentiate environmental leaders from laggards (King et al., 2005; Gao et al (2010)). This can allow firms to corner reputational as well as more tangible benefits as a reward for incurring the extra costs of environmental stewardship (Prakash and Potoski, 2006). Aurora and Gangpopadhyay (1995) find that firms participate in VEPs to secure consumer goodwill predicated on the belief that consumers will favor companies that are more "green." VEP participation can also preempt more stringent laws by reducing the "demand" for government's regulatory intervention (Maxwell et al, 2000). Innes (2006) argues that firms might also join VEPs to mitigate the risk of consumer boycott.

VEPs vary on many dimensions. We have already noted that they have been established by different types of actors. VEPs also differ in types of the obligations they impose on their participants. Typically, VEPs oblige their participants to undertake one of two types of activities: (1) achieve specific environmental targets or pollution reduction outcomes, or (2) adopt environmental management systems or technologies but without specifying environmental outcomes. To motivate enduring changes in firms' environmental performance, both approaches have pros and cons. Outcomes-focused approaches command firms to achieve measurable environmental targets but leave it to them to decide how they will accomplish these goals. We term this approach as "command without control." While this allows outside stakeholders to assess firms' progress in meeting program obligations, it does not allow them to identify specific policies the firm has put in place to achieve these outcomes. Consequently, stakeholders might remain uncertain about the durability of the pollution reducing effect of VEP participation.

VEPs that specify management systems, technologies, or processes pose different sorts of challenges because stakeholders find it difficult to assess firms' progress in meeting their program obligations. This "control without command" approach allows stakeholders to assess if the participating firm has established management systems or adopted new technologies that might translate into durable environmental improvements.

33/50 is an outcome-focused VEP. Its sponsoring actor, the EPA, sought to promote corporate environmental stewardship, but without commanding specific actions firms need to take in order to meet program obligations. The skeptical view (or the "greenwashing" perspective) would suggest that firms are likely to join this VEP if they either had already achieved the pollution reductions targets prior to joining the program or could achieve them at low costs. The observable implication is that participating firms are unlikely to invest in new technologies or management systems (beyond what they would do in the absence of participation) that would lead to pollution reductions once the program was discontinued in 1995.

Optimists might argue that, to achieve 33/50 pollution reduction commitments, participating firms will invest in technological innovations and management systems beyond what they might do in the absence of their participation. To institutionalize and support these changes motivated by 33/50 membership, these firm will probably initiate organizational and cultural changes that might have an enduring effect on their environmental performance in the future. If this logic holds, program participation will have an enduring effect on firms' environmental performance even after the program has been discontinued. Furthermore, since firms cannot always compartmentalize their environmental efforts, the effect of 33/50 membership on pollution reduction could also be observed for chemicals not targeted by this VEP.

A well-developed empirical literature explores whether VEP participation correlates with pollution reduction. Empirical research finds the efficacy in reducing pollution to vary across programs (Darnall & Kim, 2012; Rivera and DeLeon, 2004; Morgenstern & Pizer, 2007). For example, firms participating in the chemical industry's Responsible Care program (King & Lenox, 2000; Gamper-Rabindran and Finger 2013), and the U.S. Department of Energy's Climate Wise program (Welch, Mazur, & Bretschneider, 2000) did not show pollution reductions from program membership. However, Potoski and Prakash (2005) and Russo (2002) find that joining ISO 14001 reduced firms' pollution emissions. Furthermore, ISO14001 participation also improves compliance with public law, a major problem in many developing countries such as China (McGuire, 2014).

Yet, the above literature does not talk about the enduring effect of program participation on pollution reductions. One could explore this subject in two ways. First, we could examine the duration of membership as influencing program efficacy (Schembera, forthcoming); the assumption here is that firms take time to implement program requirements, especially in terms of fully operationalizing new technologies, systems and culture. Hence, program membership should be viewed as a "stock" variable instead of a "flow" variable when assessing program efficacy. Second, we could examine the enduring effect of program participation when the program has been formally or informally discontinued, as in the case of several EPA programs such as the 33/50 program, the Voluntary Reporting of Greenhouse Gases, and the Performance Track (Cogalianese and Nash, 2009). Because the external pressure to continue with program obligations has been withdrawn, this is a more demanding test for observing how the institutional legacies of program membership might influence firm's environmental performance in the future. We examine this issue in the next section in the context of the 33/50 program.

33/50 and Pollution reduction

33/50 sought to motivate firms to reduce their discharges of 17 highly toxic chemicals with fixed reduction targets. [1] Why did the EPA target these specific chemicals? While the EPA underlined the health and environmental hazards they posed, it wanted to focus on chemicals that were used and discharged in large quantities. Furthermore, the

[1] These were: Benzene, Carbon tetrachloride, Chloroform, Dichloromethane, Methyl ethyl ketone Methyl isobutyl ketone, Cadmium and cadmium compounds, Chromium and chromium compounds, Cyanide compounds, Lead and lead compounds, Mercury and mercury compounds, Nickel and nickel compounds Tetrachloroethylene, Toluene, 1,1,1-Trichloroethane, Trichloroethylene and Xylenes (USEPA, 1992).

EPA believed that it was possible and technically feasible for firms to innovate in order to reduce the discharges of these chemicals.

To recruit firms, in February 1991, the EPA invited 600 firms to participate in this program; by 1994, the EPA had invited over 8000 firms, and almost 1,200 firms pledged to participate. The EPA asked participating firms to reduce their discharges of the targeted chemicals by 33% by 1992, and by 50% by 1995 (with 1988 discharges as the baseline). Once the program was discontinued in 1995, the EPA sought to examine its success. It claimed that this program successfully surpassed its target because the participating firms reduced the discharges of targeted chemicals by 51% (while firms not non-participating reduced their emissions by an average of 38%) (USEPA, 1997).

Analytically, 33/50 is an excellent case to explore the issues of VEP efficacy and institutional legacies. First, 33/50 outlined specific outcomes that participating firms agreed to achieve. Second, this VEP focused on reducing the emissions of TRI chemicals that firms are obligated to report annually to regulators. Because TRI is a federal program, firms' compliance is monitored by regulators, a crucial issue given the important role scholars assign to third-party monitoring in motivating compliance (King and Lenox, 2000; Berliner and Prakash, 2015). Given this program design, firms have clearly defined pollution reduction expectations. However, it is less clear whether firms will continue their pollution reduction efforts once the program has been discontinued. After all, firms join VEPs to corner reputational and other benefits of their membership (King et al., 2005). This may translate into tangible benefits such as increased sales (Hendricks and Singhal, 1997), regulatory relief, lower inspection levels, or lower borrowing costs, or less tangible benefits such as increased goodwill. But what might motivate them to continue with these investments once the program has been discontinued? With a discontinued program, firms are less likely to receive such benefits, and this may demotivate them to invest resources to fulfill the environmental goals that the discontinued program had specified.

There are several reasons why firms would discontinue their pro-environmental investments once 33/50 was discontinued. First, firms joined 33/50 for the "warm glow" of environmental stewardship. Once 33/50 ended, these firms probably no longer received the branding recognition from the EPA. Arguably, absent such branding benefits from the EPA and other stakeholders, firms will be demotivated to invest in their pro-environmental behaviors. This expectation would be consistent with Carmen et al. (2013), which found that participating firms significantly increased environmental patents during the duration of 33/50, but patent activity diminished once 33/50 was discontinued.

Second, firms may have participated in 33/50 as an insurance mechanism, particularly in relation to the EPA. For example, Godfrey et al. (2009) suggest that corporate social responsibility (CSR) investments such as joining VEPs can insulate a firm from the risk of adverse events. If firms viewed 33/50 participation as an insurance mechanism, they would probably recognize that this insurance expired once 33/50 was discontinued in 1995. In this case, firms would perhaps look for alternate insurance mechanisms that may require participating in an on-going VEP.

Third, firms may have implemented the processes and innovations that were easier; in other word, firms may focused on the "low hanging fruit," to meet the 33/50 goals. Once 33/50 ended, firms innovation efforts were probably discontinued because the low hanging fruit had been harvested—leaving no positive environmental legacy after the program's end. This idea is consistent with Carmen et al (2013), who finds a "spike and bust" pattern in environmental patent innovations associated with VEP participation.

Yet, firms participating in 33/50 might be expected to continue with their pro-environmental behaviors even after the program was discontinued. First, once firms have begun investing in their pro-environmental behaviors, green stakeholders including customers, may expect this to become as the "new normal." With these expectations, firms will find it difficult to roll back their pro-environmental agenda.

Second, firms typically are skeptical about the return on investments for engaging in pro-environmental behavior. For decades, firms have been challenged to empirically demonstrate the value of intangible assets such as an environmental image. Managers often underestimate the full value of pollution reduction activities (King and Lenox, 2002). But government sponsored VEPs perhaps allowed firms to recognize the branding benefits of pro-environmental behaviors. In fact, Corbett et al. (2005) finds that firms participating in ISO 9000 experienced abnormal improvements in financial performances. Therefore, 33/50 membership experience pushed firms over the threshold to engage in pro-environmental behaviors in the future even when 33/50 was discontinued.

Third, consistent with the expectations of Ozturan et al. (2014), who finds that firms that increase advertising during a recession come out much further ahead in the post-recession period, we theorize that firms seek to distinguish themselves from their other 33/50 peers after the program was discontinued – after all, the EPA (the program sponsor) retains its extensive regulatory role and remains active in sponsoring different types of VEPs. Even though firms have an opportunity to relax their environmental efforts, they remain motivated by peer competition. The initiation of 33/50 may have started a "horse-race" that motivates firms to continue with their pro-environmental actions.

Fourth, firms may have developed the organizational and technological capabilities to undertake environmental innovations (Hoffman, 2001). By engaging in a VEP, firms enhance their organizational management skills, as reported by Levine and Toffel (2010). These include new R&D facilities, improved internal auditing, improved cooperation with business partners, and enhanced employee and management engagement to reduce emissions (Ittner et al., 2001). Once these management capabilities have been enhanced, firms have the capacity to continue reducing emissions even when the VEP has been discontinued.

Fifth, a significant amount of technical knowledge is required to identify sources to reduce emissions. It is fair to assume that firms participating in 33/50 would have devoted significant resources in this regard. Because firms cannot act upon all opportunities at once, it is possible that they acted on only a subset of these by 1995. Thus, firms may have continued with environmental innovations given that they had identified opportunities, developed capabilities and created a cadre of managers with a stake in continuing pro-environmental actions (Hoffman, 2001. Howard-Grenville et al., 2008). In the next section, we provide an empirical test of whether firms participating in the 33/50 program continued reducing emissions once the program was discontinued.

Methods and Findings

We begin by estimating the relationship between plant-level 33/50 participation and toxicity-weighted chemical emissions. Although the EPA invited firms to participate in the

33/50 program, not every plant within a participating firm actually participated in the program. By observing both 33/50 participation and emissions at the plant level, we are more likely to identify the causal effect of 33/50 participation on emissions. Toxicity weights were drawn from the US EPA's Risk-Screening Environmental Indicators (RSEI) website[2]. Summary statistics for the variables used in each model are presented in Table 1.

[Insert Table 1 Here]

We first estimate the effect of program participation on emissions of TRI chemicals targeted by the 33/50 program, and then estimate the effect of participation on emissions of other TRI chemicals <u>not</u> targeted by 33/50. To understand whether the effect of 33/50 participation might have decayed over time, we report the effect of 33/50 on emissions for three time periods separately: program life (1991-1995), first period (1996-2004), and second period (2005-2013). The reasons for choosing 2005 as the cut off are twofold. First, 2005 roughly divides the post 33/50 period into two equal halves. Second, Responsible Care VEP, an important covariate in our model, underwent a design change in 2005 because it introduced third party auditing. Hence, by looking at 1996-2004 and 2005-2013 separately, we are able to control for the possibility that this design change in Responsible

[2] Bi and Khanna (2008) use the Threshold Limit Value (TLV) weights from American Conference of Governmental Industrial Hygienists (ACGIH). TLV toxicity weights are measured as the average amount of skin/inhalation exposure a worker can withstand before suffering from negative health consequences, on the basis of an 8 hour/day (40 hour work week schedule). Because ACGIH only weight a limited number of chemicals, we adopted the EPA's toxicity measurements, in order to weight the toxicity of non-3350 chemicals in our dataset. The EPA weights measures toxicity in a similar manner: "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure [or continuous inhalation exposure the RfC] to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious [noncancer] effects during a lifetime" (EPA, 1988).

Care is the true driver of emissions reductions post-33/50. However, our results are not sensitive to the cutoff period between the second and third period.

33/50 Emissions

We begin with a difference-in-difference specification using the log of toxicity-weighted emissions of 33/50 chemicals as our dependent variable. The validity of the difference-in-difference estimator depends critically on the so-called "parallel trend" assumption, i.e. the assumption that treated and non-treated units exhibited similar trends prior to the intervention, suggesting that the observed differences are due to the intervention only. Figures 1 and 2 show the mean levels of our dependent variables for our treated (33/50 participants) and non-treated (non-33/50 participants) during the years prior to the start of 33/50, and the few years after. The start of 33/50 is indicated in each figure by the vertical line at year 1991. In each figure, the data clearly show a parallel trend for participants and non-participants before the start of 33/50. In Figure 1, we see that emissions of 33/50 chemicals were relatively flat between 1988 and 1989, and then dipped between 1989 and 1990. Differences emerge only after the start of the program, at which point we see further reductions by 33/50 participants and *increases* in emissions by non-participants. In Figure 2, we see that emissions levels were similarly flat for non-33/50 chemicals from 1988-1989, followed by a decline for both participants and non-participants up to 1991.

The model includes several plant-level characteristics as well as plant fixed effects. These plant characteristics include the number of environmental inspections made in the facility (*Number of Inspections),* the ratio of Hazardous Air Pollutants to all emissions in the

TRI database (*HAP:TRI Ratio*), and participation in the chemical industry's Responsible Care initiative (*RC Participation*). *Number of Inspections* and *HAP:TRI Ratio* are included as measures of the regulatory pressure on the facility to reduce emissions. *RC Participation* is included to ensure that the estimated marginal effects from *33/50* are not confounded by facility's participation in this related VEP. Indeed, within our sample, firms that participate in 33/50 are significantly more likely to participate in Responsible Care (p=0.00). Controlling for *RC Participation* will help ensure the estimated coefficients on *33/50* are unbiased.

We also include several state and county-level controls to account for the effect of the local political and economic context on the facility's emissions decisions. We include the score given to each facility's state legislature by the League of Conservation Voters (*State LCV Score*) as a measure of how environmentally friendly is the facility's home state. We also include two variables counting the number of chemicals for which the facility's home county was not in compliance with the 1977 Clean Air Act, either in whole (*Whole Non-Attainment)*) or in part (*Partial Non-Attainment).* These are proxies of how stringently local agencies enforce environmental regulations. Finally, we control for county-level median household income in case wealthier regions put more pressure on local facilities to reduce emissions. Estimation results are presented in column (1).

[Insert Table 2 Here]

The coefficients on our 33/50 variables represent the difference between 33/50 participants and non-participants in the difference in average emissions levels between the specified time period and the base period prior to the 33/50 program (1988-1990). Assuming our identifying assumptions hold, the coefficient can be interpreted as the causal effect of 33/50 on the average level of toxicity-weighted emissions during the specified period. The results in column (1) indicate that 33/50 reduced emissions during the life of the program (1991-1995) by 25%. In the period immediately following the end of the program (1996-2004), 33/50 participation reduced emissions by 33%. When we extend our analysis to the final time period in our data (2005-2013), we find that 33/50 participation reduced emissions by 28%. Although the point estimates vary across these three periods, these differences are not statistically significant (p=0.35). This implies that the emissions reductions caused by 33/50 during the life of the program persisted up to at least 2013. Among all our additional controls, only *HAP:TRI Ratio* and the *Non-Attainment* variables show a statistically significant relationship with emissions. Toxicity-weighted emissions were higher for firms with a higher *HAP:TRI Ratio*, and also for plants in counties that had failed to meet more of the Clean Air act standards.

We might doubt the causal interpretation of these estimates if we believe that participation in 33/50 is correlated with an omitted factor not included in the extensive plant-level controls included in our model, or adequately dealt with by our plant fixed effects. To address this possibility, we re-estimate the model in column (1) using an instrumental variable (IV) approach. These results are presented in column (2). Our excluded instrument is a dummy variable equal to one if the plant was owned by one of the first 600 firms invited to join the 33/50 program by the EPA[3]. This instrument was also employed by Bi and Khanna (2012), who argued it was likely a valid instrument for two reasons: 1) the letter was received by the parent company and not the plant, so it is

[3] We also estimated these models using the one year lag of two digit SIC industry-level 33/50 participation (excluding the focal firm) as an instrument. The results were largely the same, though the point estimates on 33/50 participation tended to be larger.

unlikely to be correlated with plant-level emissions, and 2) the EPA chose these firms not because of their emissions, but because they were ranked among the top companies by *Fortune* magazine. The instrument is a strong predictor of 33/50 participation (p=0.00), though we are not able to test its validity, given that the system of equations is exactly identified.

The results of our IV estimator indicate a much larger effect of 33/50 participation on emissions in every time period compared to previous specifications. For period 1 (1991-1995), the IV estimator finds that participation reduced emissions by 66%. The effect of 33/50 on emissions was significantly larger (p=0.01) in the second period (1996-2005); where we see that participation reduced toxicity weighted emissions by more than 90%. This large reduction in emissions appears to persist into period 3 (2005-2013).

This specification also shows more significant relationships between emissions and our additional control variables. Firms participating in the RC program exhibit significantly higher levels of emissions, consistent with King and Lenox's (2000) finding on the RC program. The same is true for firms with higher *HAP:TRI Ratios.* Plants subject to more frequent inspections appear to reduce emissions, while plants in counties that failed to meet EPA standards (*Non-Attainment*) polluted more. Plants in states with legislatures given high ratings by the LCV appear to pollute less.

Finally, column (3) presents results for a dynamic panel specification of the model. Here, we follow the work of Bi and Khanna (2012) who show that emissions can follow a dynamic adjustment process that is best modeled with the dynamic panel estimator described in Arellano and Bond (1991).[4] These results show that 33/50 participants cut emissions, but the effects are much weaker in every time period compared to our other specifications. However, the Hansen test rejects the null that the instruments generated by the estimator are valid, so these results may be biased.

Non-33/50 Emissions

Because we are also interested in how participation in 33/50 might "spill over" into emissions of non-33/50 chemicals, we re-estimated the models presented in Table 2 using the log of toxicity-weighted non-33/50 chemical emissions as our dependent variable. The specifications are otherwise similar to those discussed above.

[Insert Table 3 Here]

Column (1) presents results for our difference in difference specification in with plant fixed effects and additional controls. These results suggest that participation in 33/50 was associated with reductions in non-33/50 emissions throughout the sample period, and that those reductions grew over time (p=0.00). 33/50 participation reduced emissions by 10% during 1991-1995, by 26% during 1996-2004, and by 58% during 2005-2013. Several of our control variables are also significant in this specification. *RC Participation* was associated with higher emissions. Plants also emitted more in counties that failed to meet more EPA standards (*Non-Attainment)*. Firms that were inspected more frequently also emitted more, while firms with a higher *HAP:TRI Ratio* emitted less.

[4] Roodman (2006) points out that the dynamic panel model is often mis-specified and can produce unreliable results if not used carefully. It is also not necessary to model the dynamic adjustment process to produce an unbiased estimate of the causal effect of 33/50 on emissions.

In Column (2), we use an instrumental variables approach to control for the possibility that participation and emissions are both affected by an omitted factor not adequately controlled by the included plant characteristics or plant fixed effects. Once again, we use the EPA's invitation to the first 600 firms as our instrument. As we saw in Table 2, employing an instrumental variables approach increases the point estimate of the estimated marginal effects. We still see that 33/50 reduced emissions during every period in the data, and that these emissions reductions grew over time (p=0.00). 33/50 participation reduced emissions by 27% during 1991-1995, 44% during 1996-2004, and by 94% during 2005-2013. The estimated coefficients on our other plant characteristics are similar to those reported in column (1).

Finally, Column (3) presents the results of our dynamic panel model using the log of non-33/50 chemicals as our dependent variable. In this case, we estimate a positive effect of 33/50 participation on emissions, though we have the same concerns here about instrument validity that were discussed above. The Hansen test again rejects the null that the instruments generated by the estimator are valid, implying that these results may be biased.

Program Participation and Environmental Innovation

So far we have presented the finding that 33/50 participants reduced the emissions of 33/50 targeted chemicals as well as non-targeted chemicals during the life of the program (1991-1995) as well as after the program was discontinued (1996-2013). In this section, we explore a specific mechanism that may have played a critical role in contributing to emission reductions. Specifically, we explore how 33/50 participation affected environmental innovations.

Carmen et al (2013) find that 33/50 spurred environmental patent filing during the life of the program; however, once the program ended in 1995, there was a decline in environmental patent filings. This suggests that 33/50 successfully encouraged patentable innovation during its lifespan, but it left a negative legacy effect on patentable innovations once it was discontinued. We approach the issue of environmental innovation by examining both patented as well as non-patented innovations, both subsumed under source reduction activities (SRAs). Emissions reductions we have reported might result from the treatment or recycling of emitted chemicals, or plants may develop new processes to prevent these emissions from being generated in the first place. These latter innovations are known as Source Reduction Activities (SRAs)[5], and may lead to the type of durable emissions reductions implied by our empirical findings. We believe our approach is superior to the one adopted by Carmen et al. (2013) for three reasons.[6] First, patent data excludes innovations that are either not patentable, or the ones that firms choose not to patent.

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[5] The Source Reduction Activities categories include: good operating practices, spill and leak prevention, inventory control, cleaning and decreasing, process modifications, raw material modifications, product modifications, and surface preparation and finishing.

[6] Unlike Carmen et al. (2012), our model also controls for participation in Responsible Care—the most active VEP in the chemical industry. By accounting for Responsible Care, we ensure that environmental innovations ascribed to 33/50 are not simply the result of this important, and often omitted, variable. The omission of Responsible Care is likely due to the difficulty of tracking the historical membership data; the American Chemistry Council (ACC) only shows a current membership page. The ACC staff also claimed they do not have a historical membership data available for release. To hand collect this unique data, we use recorded participation membership webpages on the ACC website at the end of each year for 2002-2015. RC membership for the pre-2002 period was provided by Andrew King and Michael Lenox.

Using the EPA's SRA data, we offer a more comprehensive study of the relationship between 33/50 membership and environmental innovation. We are encouraged by the fact that prior research reports that SRA adoption correlates with emission reductions: Ranson et al (2015) finds that the average SRA reduces emissions by 9-16%.

Second, as Carmen et al (2013) acknowledge, patent data does not allow researchers to disaggregate patents down to the chemical level. Because 33/50 targeted 17 chemicals only, it is important to use more granular innovation data at the chemical level. A focus on SRAs allows us to do so.

Third, SRA data focuses only on the implementation of environmental innovations, whereas patent data does not necessarily signify implementation that translated into concrete pollution reduction outcomes. In fact, firms routinely file environmental patents and then let the patent be idle, or sell the patent rights to another company after some time. Thus, to explore the link between 33/50 participation and emission reductions, we need to focus on innovations that have been actually implemented, not merely filed.

To investigate the relationship between 33/50 participation and SRAs, we re-estimate the models presented in Tables 2 and 3 using the plant-level count of SRAs for 33/50 and non-33/50 chemicals as dependent variables. Once again, we emply a difference-in-difference estimator, which relies critically on the parallel trend assumption. To check for a parallel trend, we can compare the average number of SRAs among 33/50 participants and non-participants before the start of the program. Figure 3 shows the average number of SRAs for 33/50 chemicals, while Figure 4 shows the average number of SRAs for non-33/50 chemicals. In both cases, SRAs were stable and very close to zero for both participants and non-participants before the start of the 33/50 program in 1991, implying the parallel trend assumption holds. We see an increase in SRAs for both participants and non-participants once the program begins, though the increase is much larger for participating plants.

[Insert Table 4 Here]

33/50 SRAs

Table 4 presents estimation results using the count of SRAs for 33/50 chemicals as our dependent variable. The specification reported in column (1) includes 33/50 participation along with additional plant characteristics and plant fixed effects. These results indicate that 33/50 participation increased the number of SRAs during the life of the program (1991-1995), but this effect appears to "decay" in later time periods (p=0.00). On average, 33/50 participants produced an additional 0.6 SRAs during the program. This effect falls to 0.1 during 1996-2004, and zero during the final period in our data, 2005-2013. This implies that 33/50 gave a temporary boost to SRAs, but there was no difference between participants and non-participants by the third period in our data.

Several of our control variables are also significant in column (1). Firms with higher *HAP: TRI Ratio*s or that were inspected more frequently appear to innovate less. Firms in counties that failed to meet EPA standards (*Non-Attainment)* or with higher median incomes were more likely to produce SRAs.

In column (2), we use an instrumental variables approach to estimate the effect of 33/50 on SRAs. Again, we use the EPA invitation as our instrument. These results suggest a much larger positive effect of 33/50 on SRAs during the program (an additional 1.1 on average), with a pattern of "decay" similar to what we saw in column (1). Participants produced an additional 0.4 SRAs during 1996-2004, and an additional 0.2 SRAs during

2005-2013. The coefficients on the rest of our controls are similar to the results in column (1), except that RC participation is now associated with a significant decrease in SRAs.

Finally, column (4) presents the results of our dynamic panel specification. These results imply that 33/50 participation led to an additional 0.4 SRAs during 1991-1996, but had no significant effect in subsequent periods. Unlike our the dynamic panel results reported in Tables 2 and 3, we have reason to believe the instruments used in this specification are valid, and the results are more reliable. The Hansen test fails to reject the null that our instruments are valid at any standard level of significance.

[Insert Table 5 Here]

Non-33/50 SRAs

Table 5 presents estimation results replicating the models in Table 4, but using the count of SRAs for non-33/50 chemicals as our dependent variable. Overall, the results are very similar, except that 33/50 participation appears to produce much larger increases in non-33/50 SRAs than it did for 33/50 SRAs. Column (1) presents the results of our difference-in-difference estimator with plant-level controls and fixed effects. Participation led to an additional 1.9 SRAs during the life of the program, an additional 1 SRA immediately following the program, and an additional 0.4 SRAs in the final period of our data. This pattern of "decay" is similar to what we found in Table 4. Plants with a higher *HAP:TRI Ratio* produced fewer SRAs, as did firms that were inspected more frequently. Plants produced more SRAs if they were located in counties that did not meet more of the Clean Air standards.

In column (2), we use an instrumental variables approach to estimate the model, using the same EPA invitation as our instrument. Once again, the IV approach produces larger point estimates for the effect of 33/50 participation on SRAs, with a pattern of "decay" similar to what is shown in column(2). Participants produced an additional 4.8 SRAs in period 1, an additional 2.6 SRAs in period 2, and an additional 1.7 SRAs in period 3. The estimated coefficients are the additional control variables are nearly identical to those reported in column (1), except that a higher *LCV Score* is now associated with significantly higher SRAs.

Column (3) presents results for our dynamic panel estimator. Once again, the Hansen test strongly supports the validity of the instruments generated by the estimator (p=0.67). As in Table 3, the dynamic panel estimator only shows a significant positive relationship between 33/50 participation and SRAs during the life of the program: Participants produced an additional 1.5 SRAs in period 1. There appears to be no effect in period 2, and we actually see a small *decrease* in SRAs in the final period in our data. This is similar to the result reported in Carmen et al (2013), though it is interesting to note that it appears only in one specification, and only for SRAs associated with non-33/50 chemicals.

Conclusion

Scholars assert that institutions play an important role in structuring our choices, and shaping organizational outcomes (Williamson, 1985). We agree and take the argument a step forward. We suggest that institutions can continue to matter, even when they are declared "dead." Of course, this raises question as to whether all institutions leave their legacies for the future. If not, what might explain which do and which don't? Our paper offers some interesting insights on this subject.

Institutional interventions such can be viewed as 33/50 are exogenous "shocks" that can initiate internal organizational processes that might acquire a life of their own. This is because institutional changes might alter the status quo within organizations, creating new coalitions that develop an interest and shared understanding in maintaining the new equilibrium. Viewed this way, joining 33/50 probably had important sociological and political consequences for participating firms that influenced how firms and their managers think about environmental innovation. Consequently, even when 33/50 was discontinued, firms continued with the innovation processes that were initiated by arguably an exogenous intervention. This likely contributed to the persistence of emissions reductions achieved during 33/50, even though the program has ended.

By demonstrating the institutional legacy of 33/50 on toxic emissions even after the program was discontinued, our paper opens up a series of important theoretical and policy questions. Programs designs can change: for example programs might introduce new features as third-party aiding. Program death might be an extreme version of design change. Thinking of changes in program design as a continuum, not as a binary variable (continuing or discontinued), can allow scholars to examine a range of programs that have altered the obligations they impose on their participants. Within the chemical industry, these include the Responsible Care (1985), ISO: 9000 (1987), Responsible Distribution Process (1991), and ChemSteward (2005). Each of these programs have undergone changes in stringency over the course of their continued life span. The question then is how these past institutional templates have influenced firms' performance with the new institutional design. Similarly, how can policy makers leverage past programs when they introduce new ones so as to work with the social and political capital that the previous initiative might have left in the firm?

Finally, a word of caution. Institutional legacies are not always positive; they can also create hurdles for desirable changes in the future. Arguably, a failed VEP might unleash negative dynamics within the organization that make the firm and its employees wary of participating in new VEPs in the future. Thus, scholars should assess both positive and negative legacies that institutions might create for the future.

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Table 1
Summary Statistics

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Log 33/50 Emissions	15.043	5.194	-5.627	33.220
Log non-33/50 Emissions	15.232	4.218	-6.502	33.627
33/50 Chemical SRAs	0.648	2.094	0	72
Non-33/50 Chemical SRAs	0.861	4.518	0	255
33/50 (1991 ≤ Yr ≤ 1995)	0.085	0.278	0	1
33/50 (1996 ≤ Yr ≤ 2004)	0.095	0.293	0	1
33/50 (2005 ≤ Yr ≤ 2013)	0.051	0.220	0	1
RC Participation	0.057	0.231	0	1
HAP:TRI Ratio	0.369	0.382	0	1
Number of Inspections	0.895	2.327	0	12
LCV Score	48.726	23.076	0	100
Whole Non-Attainment	2.640	6.163	0	189
Partial Non-Attainment	1.260	5.069	0	342
Log Median Income	10.070	1.444	4.218	13.648

Table 2

The Effect of 33/50 Participation on Toxicity-Weighted Emissions of 33/50 Chemicals

	(1) FE	(2) FE-IV	(3) Dynamic Panel
33/50 (1991 ≤ Yr ≤ 1995)	-0.246***	-0.666***	-0.073*
	(0.000)	(0.000)	(0.077)
33/50 (1996 ≤ Yr ≤ 2004)	-0.330***	-0.935***	-0.117***
	(0.000)	(0.000)	(0.000)
33/50 (2005 ≤ Yr ≤ 2013)	-0.277**	-0.894***	-0.054
	(0.027)	(0.000)	(0.169)
RC Participation	0.140	0.109**	-0.149
	(0.126)	(0.028)	(0.195)
HAP:TRI Ratio	1.434***	1.427***	-0.136
	(0.000)	(0.000)	(0.345)
Number of Inspections	-0.010	-0.009**	-0.019**
	(0.156)	(0.025)	(0.033)
LCV Score	-0.001	-0.001*	-0.001**
	(0.291)	(0.068)	(0.040)
Whole Non-Attainment	0.036***	0.036***	0.007***
	(0.000)	(0.000)	(0.000)
Partial Non-Attainment	0.034***	0.033***	0.004***
	(0.000)	(0.000)	(0.006)
Log Median Income	-0.001	-0.002	-0.017***
	(0.946)	(0.789)	(0.002)
Log Emissions (t-1)			1.011***
			(0.000)
Constant	13.892***		
	(0.000)		
Observations	197,556	194,686	164,048
R-squared	0.031	0.029	
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes
Overid p-value	N/A	N/A	0.00
Number of id	23,285	20,415	20,023

Notes:

1. Robust pval in parentheses: *** p<0.01, ** p<0.05, * p<0.1
2. The dependent variable in every specification is the log level of toxicity-weighted emissions of 33/50 chemicals
3. 33/50 participation enters into each specification as the interaction between a dummy variable for the specified time period and a dummy variable equal to one if the plant participated in the 33/50 program
4. The "Overid p-value" is for the Hansen test of the null hypothesis that the instruments generated by the dynamic panel GMM estimator are valid.
5. The instrument matrix for the dynamic panel estimator contains 4th year lags of the potentially endogenous variables along with our "external" instrument used in column (3)

Table 3

The Effect of 33/50 Participation on Toxicity-Weighted Emissions of non-33/50 Chemicals

VARIABLES	(1) FE	(2) FE-IV	(3) Dynamic Panel
33/50 (1991 ≤ Yr ≤ 1995)	-0.107*	-0.268*	0.154***
	(0.080)	(0.087)	(0.006)
33/50 (1996 ≤ Yr ≤ 2004)	-0.259***	-0.438**	0.086*
	(0.004)	(0.015)	(0.068)
33/50 (2005 ≤ Yr ≤ 2013)	-0.581***	-0.940***	0.046
	(0.000)	(0.000)	(0.273)
RC Participation	0.200**	0.185***	0.334**
	(0.018)	(0.000)	(0.010)
HAP:TRI Ratio	-1.341***	-1.344***	0.307
	(0.000)	(0.000)	(0.172)
Number of Inspections	0.016***	0.017***	-0.007
	(0.006)	(0.000)	(0.500)
LCV Score	-0.001	-0.001	-0.003***
	(0.475)	(0.255)	(0.000)
Whole Non-Attainment	0.032***	0.032***	0.013***
	(0.000)	(0.000)	(0.000)
Partial Non-Attainment	0.021***	0.021***	0.007***
	(0.000)	(0.000)	(0.000)
Log Median Income	0.005	0.005	-0.036***
	(0.703)	(0.531)	(0.000)
Log Emissions (t-1)			0.883***
			(0.000)
Constant	15.036***		
	(0.000)		
Observations	120,706	118,376	97,838
R-squared	0.032	0.032	
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes
Overid p-value	N/A	N/A	0.00
Number of id	15,115	12,785	12,417

Notes:

1. Robust pval in parentheses: *** p<0.01, ** p<0.05, * p<0.1
2. The dependent variable in every specification is the log level of toxicity-weighted emissions of 33/50 chemicals
3. 33/50 participation enters into each specification as the interaction between a dummy variable for the specified time period and a dummy variable equal to one if the plant participated in the 33/50 program
4. The "Overid p-value" is for the Hansen test of the null hypothesis that the instruments generated by the dynamic panel GMM estimator are valid.
5. The instrument matrix for the dynamic panel estimator contains 3rd year lags of the potentially endogenous variables along with our "external" instrument used in column (3)

Table 4
The Effect of 33/50 Participation on SRAs for 33/50 Chemicals

VARIABLES	(1) FE	2) FE-IV	(3) Dynamic Panel
33/50 (1991 ≤ Yr ≤ 1995)	0.560***	1.100***	0.352***
	(0.000)	(0.000)	(0.000)
33/50 (1996 ≤ Yr ≤ 2004)	0.143***	0.383***	0.008
	(0.001)	(0.003)	(0.804)
33/50 (2005 ≤ Yr ≤ 2013)	-0.051	0.241*	-0.035
	(0.275)	(0.095)	(0.297)
RC Participation	-0.076	-0.084**	-0.128
	(0.211)	(0.049)	(0.411)
HAP:TRI Ratio	-0.048*	-0.049**	-0.473***
	(0.088)	(0.016)	(0.010)
Number of Inspections	-0.017***	-0.017***	0.003
	(0.000)	(0.000)	(0.842)
LCV Score	0.000	0.000	0.000
	(0.898)	(0.875)	(0.889)
Whole Non-Attainment	0.011***	0.011***	0.008***
	(0.008)	(0.000)	(0.000)
Partial Non-Attainment	0.028***	0.027***	0.011***
	(0.000)	(0.000)	(0.006)
Log Median Income	0.022**	0.022***	-0.016**
	(0.020)	(0.000)	(0.014)
33/50 SRAs (t-1)			0.726***
			(0.000)
Constant	-0.548**		0.366*
	(0.012)		(0.072)
Observations	197,556	194,686	164,048
R-squared	0.063	0.061	
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes
Overid p-value	N/A	N/A	0.37
Number of id	23,285	20,415	20,023

Notes:

1. Robust pval in parentheses: *** p<0.01, ** p<0.05, * p<0.1
2. The dependent variable in every specification is the count of SRAs for all 33/50 chemicals
3. 33/50 participation enters into each specification as the interaction between a dummy variable for the specified time period and a dummy variable equal to one if the plant participated in the 33/50 program
4. The "Overid p-value" is for the Hansen test of the null hypothesis that the instruments generated by the dynamic panel GMM estimator are valid.
5. The instrument matrix for the dynamic panel estimator contains 7^{th} year lags of the potentially endogenous variables along with our "external" instrument used in column (3)

Table 5

The Effect of 33/50 Participation on SRAs for non-33/50 Chemicals

VARIABLES	(1) FE	(2) FE-IV	(3) Dynamic Panel
33/50 (1991 ≤ Yr ≤ 1995)	1.861***	4.770***	1.484***
	(0.000)	(0.000)	(0.000)
33/50 (1996 ≤ Yr ≤ 2004)	0.956***	2.611***	0.029
	(0.000)	(0.000)	(0.804)
33/50 (2005 ≤ Yr ≤ 2013)	0.347***	1.680***	-0.251**
	(0.003)	(0.000)	(0.023)
RC Participation	0.019	-0.020	1.051
	(0.924)	(0.887)	(0.180)
HAP:TRI Ratio	-0.337***	-0.336***	-1.994***
	(0.000)	(0.000)	(0.000)
Number of Inspections	-0.029***	-0.027***	0.063
	(0.000)	(0.000)	(0.180)
LCV Score	0.002	0.002**	-0.000
	(0.114)	(0.037)	(0.519)
Whole Non-Attainment	0.005	0.005	0.025***
	(0.772)	(0.583)	(0.002)
Partial Non-Attainment	0.052***	0.049***	0.020**
	(0.001)	(0.000)	(0.031)
Log Median Income	0.015	0.020	-0.078***
	(0.391)	(0.154)	(0.000)
Non-33/50 SRAs (t-1)			0.658***
			(0.000)
Constant	-0.935		
	(0.417)		
Observations	197,556	194,686	164,048
R-squared	0.032	0.019	
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes
Overid p-value	N/A	N/A	0.631
Number of id	23,285	20,415	20,023

Notes:

1. Robust pval in parentheses: *** p<0.01, ** p<0.05, * p<0.1
2. The dependent variable in every specification is the count of SRAs for all non-33/50 chemicals
3. 33/50 participation enters into each specification as the interaction between a dummy variable for the specified time period and a dummy variable equal to one if the plant participated in the 33/50 program
4. The "Overid p-value" is for the Hansen test of the null hypothesis that the instruments generated by the dynamic panel GMM estimator are valid.
5. The instrument matrix for the dynamic panel estimator contains 7th year lags of the potentially endogenous variables along with our "external" instrument used in column (3)

Figure 1
Mean Levels of 33/50 Chemical Emissions Before and After 1991

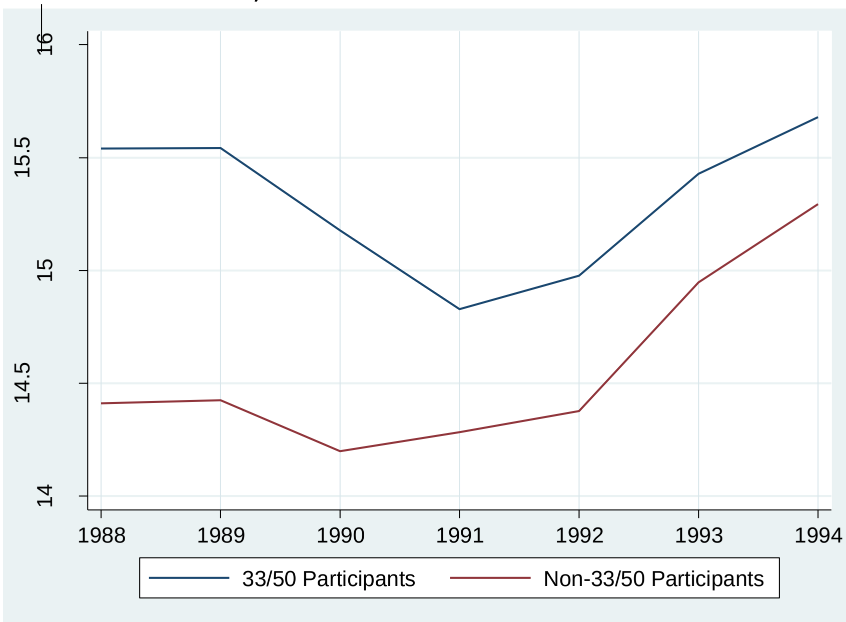

Figure 2
Mean Levels of Non-33/50 Chemical Emissions Before and After 1991

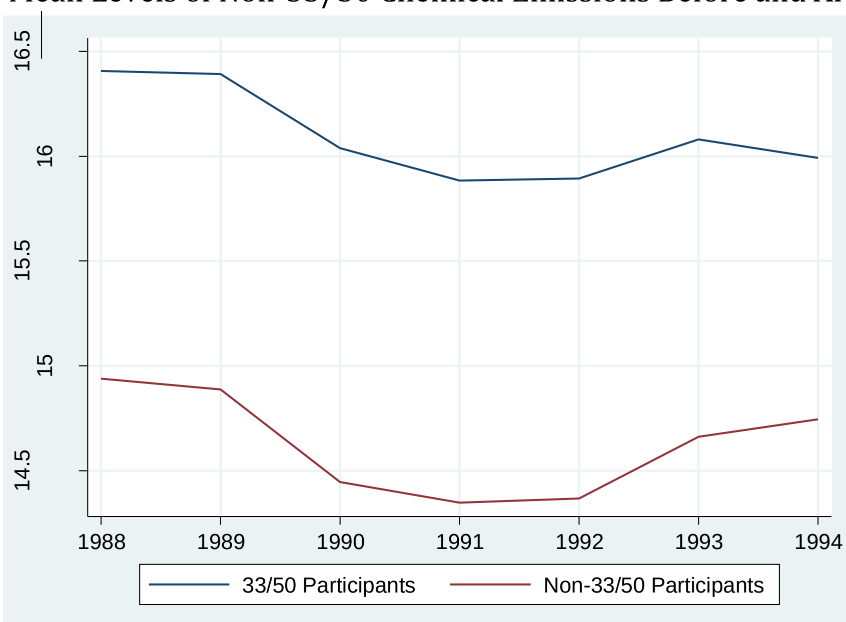

Figure 3
Mean Number of SRAs for 33/50 Chemicals Before and After 1991

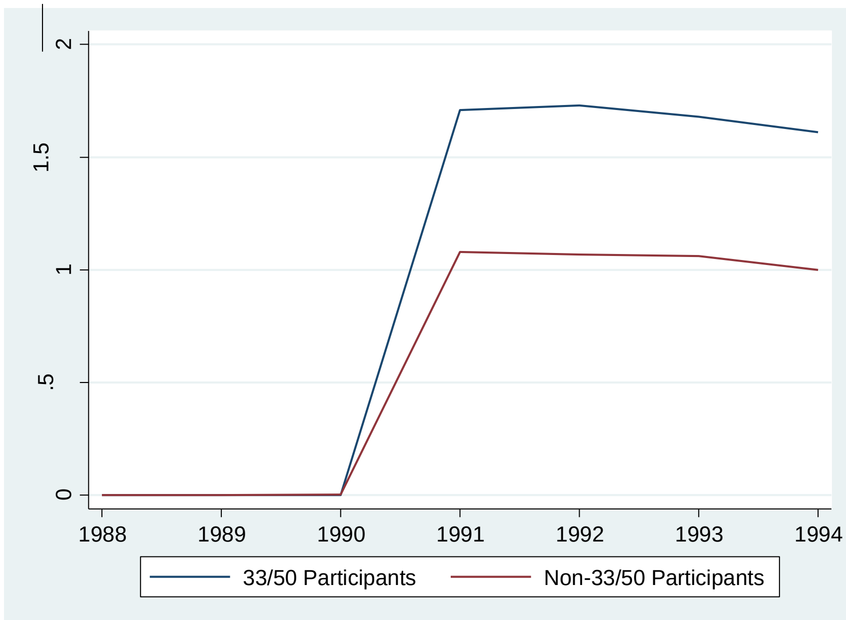

Figure 4
Mean Number SRAs for Non-33/50 Chemicals Before and After 1991