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Financial Constraints and Corporate Environmental Responsibility

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Financial constraints and corporate environmental responsibility

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Abstract

This paper analyzes the effect of financial constraints on firms' corporate social responsibility. Exploiting heterogeneity in firms' exposure to a monetary policy shock in the U.S., which reduced financial constraints for some firms, I find that firms increase their environmental responsibility. I use facility-level data to account for unobservable time-varying influences on pollution and find that toxic emissions decrease when parent companies are more exposed to the monetary policy shock. I further find that these facilities are also more likely to implement pollution abatement activities. Examining within-parent company heterogeneity I find that pollution abatement investments center on facilities at greater risk of facing additional costs due to environmental regulation. The findings are consistent with the idea that a reduction in financial constraints reduces pollution as it allows firms to implement pollution abatement measures.

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1 Introduction

Whether firm managers should engage in socially responsible behavior is a widely debated topic among investors and economists. Proponents of firm's investment in corporate social responsibility (CSR) argue that socially responsible investments maximize shareholder value. For instance, a firm's CSR may boost its social capital, enabling the firm to build trust with investors, which lowers financing costs (Lins et al., 2017; Amiraslani et al., 2018).[1] Empirical findings also show that typically well-governed firms display higher CSR ratings (Liang and Renneboog, 2017; Ferrell et al., 2016). Opponents of firm's CSR investments, however, argue that CSR is the result of agency problems between firm owners and managers and managers engage in wasteful CSR spending as benefits from CSR investment only accrue to their private benefits (Cheng et al., 2013).

In this paper, I examine whether financial constraints affect firms' socially responsible investments, particularly firms' focus on the environment and their effort to reduce pollution. To identify this, I exploit heterogeneity in firms' exposure to an unconventional monetary policy shock in the United States and pin down the causal impact of (an alleviation of) financial constraints on firms' environmental responsibility, pollution and the investment in emission reduction activities.

Whether financial constraints play a role for corporations' environmental responsibility is an open question. On the one hand, investments to reduce pollution and save energy are quite large and often hold little cost-savings potential (Fowlie et al., 2015; Walker, 2013; Greenstone et al., 2012). Costs due to complying with environmental regulation, on the other hand, can be substantial (Greenstone, 2002; Walker, 2011).

Identifying a causal link running from financial constraints to firms' stewardship

[1] Lins et al. (2017) and Amiraslani et al. (2018) find that firms that displayed higher CSR ratings prior to the financial crisis were more likely to obtain financing during the financial crisis.

toward the environment is particularly difficult for two reasons. First, unobservable factors may jointly determine a firm's financial resources and its corporate environmental responsibility (Kubik et al., 2011). Decreasing pollution, for instance, can be quite costly and investments to ensure that a firm does not violate environmental regulations can limit a firm's financial flexibility (Greenstone, 2002; Shapiro and Walker, 2017). Complying with regulatory standards thus not only determines a firm's pollution, but also its financial constraints. Second, information regarding firms' observable level of level is often not easily available as firms are not required to report figures on emissions. To gauge a firm's focus on the environment researchers therefore rely on CSR ratings.[2] These CSR measures, however, do not necessarily indicate that firms are also becoming cleaner in their production process.

Understanding determinants of corporate environmental responsibility and firms' focus on reducing pollution is important as a deteriorating environment poses detrimental effects on the standard of living and economic outcomes.[3] Policy makers are thus constantly considering mechanisms and regulations to reduce pollution and curb the emission of toxic chemicals. Identifying to what extent financial constraints shape a firm's pollution is thus of importance and helps to improve mechanisms and regulations to reduce emissions.

To isolate the causal link, running from a firm's financial constraints to its environmental responsibility, I exploit (1) the unexpected reduction in financing costs for long-term debt due to the unconventional monetary policy shock of the Federal Re-

[2]Data providers, such as MSCI, Thomson Reuters or Vigeo provide so-called Economic, Social and Corporate Governance (ESG) scores. These scores,which are based on public as well as proprietary information, report a firm's percentile ranking with respect to different CSR dimensions.

[3]The Lancet report concludes that pollution around the globe contributes to about 9 million premature deaths in 2015 (Landrigan et al., 2017). Moreover, pollution can have long-lasting effects on the real economy: Isen et al. (2017) find that a higher pollution level in the year of birth in the U.S. is associated with lower labor force participation and lower earnings 30 years later. Lower pollution in the U.S. is not only found to improve health and reduce child mortality (Chay and Greenstone, 2003), but also contributes to higher house prices (Chay and Greenstone, 2005).

serve's Maturity Extension Program, and (2) heterogeneity in firms' exposure to this shock due to their dependence on long-term debt. These two building blocks allow me to pin down the causal effect of financial constraints on environmental responsibility.

My identification strategy builds on theories arguing that non-financial firms with a preference for long-term debt benefit more from a negative supply shock of long-term government debt. In the presence of partial segmentation in bond markets and limits to arbitrage, market participants and firms have a preference for a specific maturity structure and non-financial corporations respond to a reduction of long-term government debt by filling the resulting gap in bond markets (Vayanos and Vila, 2009; Greenwood et al., 2010). Moreover, the reduction in the supply of long-term government debt reduces rates for long-term debt and firms with a preference for long-term debt financing hence experience more favorable bond rates (Baker et al., 2003). Empirical evidence finds that firms benefit from a negative supply shock and respond by issuing (cheaper) long-term debt (Greenwood and Vayanos, 2014; Badoer and James, 2016).

The Federal Reserve's Maturity Extension Program (MEP), announced in September 2011, reduced financing costs as it led to a decrease in the supply of long-term Treasury securities. Specifically the MEP put pressure on longer interest rates and reduced costs of capital for long-term bonds. Differences in firms' innate long-term debt dependence thus translates into differences in their exposure to the relaxation of financing constraints due to the MEP. Moreover, since the MEP was not anticipated it represents an exogenous shock to firms' financial constraints. Examining the effects of the MEP, Foley-Fisher et al. (2016) finds that firms with a higher dependence on long-term debt experience an boost in their value and expand their operations and investments.[4]

[4]Empirical evidence from Europe corroborates this as Grosse-Rueschkamp et al. (2018) shows that European firms, affected by the European Central Bank's Securities Purchase Program also benefited from this unconventional monetary policy.

I start by examining how a firm's differential exposure to the MEP affects its corporate environmental responsibility using relative ratings, provided by Thomson Reuters. Thomson Reuters gathers information on a firm's performance and effectiveness towards different CSR dimensions and reports a firm's relative environmental responsibility ranking to other firms. Building on the empirical set-up of Foley-Fisher et al. (2016), I find that firms with a greater dependence on long-term debt improve their Environmental Responsibility Score significantly after the implementation of the MEP. This effect is (a) robust to the addition of further fixed effects and (b) not sensitive to the definition of long-term debt dependence. Furthermore I find that the improvement of a firm's focus on the environment stems primarily from firms' heightened focus on reducing emissions and their efforts towards using resources more efficiently.[5] Examining the time-pattern of a firm's efforts regarding the reduction of emissions shows that firms with a greater long-term debt dependence don't behave differently to other firms prior to the MEP. Once, the Federal Reserve implements the MEP, however, firms with a greater long-term debt dependence significantly improve their relative performance with respect to reducing emissions.

To examine whether an increase in a firm's focus on the reduction of emissions is also reflected by an actual reduction of toxic emissions, I examine emissions data at the facility-level in the U.S., collected by the U.S. Environmental Protection Agency (EPA). Using information from the EPA's Toxic Release Inventory (TRI) I analyze whether facilities reduce toxic emissions more following the MEP if they belong to parent companies with a greater long-term debt dependence. The advantage of the TRI is that it reports the total release of toxic chemicals at the plant-level and thus provides micro-level information regarding of U.S. firms' pollution behavior.[6]

[5] I find that firms with a greater exposure to the MEP only affects environmental responsibility and do not change other aspects of their corporate social responsibility.

[6] Aggregating the emission information at the firm is problematic as reporting criteria change over the sample period and new chemicals were added to the list of reported chemicals. Using changes in

Using these micro data, I find that plants, belonging to parent companies with a greater long-term debt dependence reduce toxic emissions more following the MEP. This supports the findings at the firm-level and shows that the MEP had an effect on the environment as it reduces plants' toxic emissions.

Since the TRI provide detailed information on a facility's location, its industry classification and a break-down of toxic emissions by chemicals I can account for the influence of several unobservable influences on toxic emissions in my analysis. By including fixed effects to capture time-varying unobservable effects on toxic emissions at the facility- and industry-level, for instance, I account for differences in the stringency of environmental regulations across areas and industries. The results are robust across all specifications. Moreover, I continue to find that a parent company's greater long-term debt dependence leads to a reduction in toxic emissions if I restrict to chemicals commonly emitted during the production process. Although firms self-report their level of toxic emissions in the TRI, I do not find that a self-reporting bias explains the results: using information on the level of hazardous pollutants, measured daily at monitoring sites across the U.S., I find that following the MEP hazardous pollution decreases more in areas where plants belong to parent companies with a greater long-term debt dependence.

Following this, I use the facility-level data to examine whether facilities invest in activities to reduce toxic emissions. The TRI reports for each chemical whether the facility implemented measures to reduce toxic emissions and using that information I find that facilities that belong to parent firms with a greater long-term debt dependence are more likely to implement pollution abatement procedures following the MEP. This finding is robust to the addition of several fixed effects and also holds if I focus on chemicals that are commonly emitted in the production process.

the release of chemicals at the plant level allows me to control for changes in the reporting requirements at the plant-chemical level.

Since violating environmental regulations can be costly, I analyze whether facilities at risk of additional costs due to the violation of environmental regulations are more likely to implement emission reduction activities. Specifically, I hypothesize that the MEP should lead to an increase in the implementation of pollution abatement measures at (a) facilities that are under closer scrutiny by the EPA due to a prior violation and (b) facilities located in areas more prone to regulatory intervention due to a deterioration of air quality. My results show that particularly plants belonging to either of the two aforementioned groups are more likely to invest in emission reduction activities.

Finally, I exploit variation in the implementation of emission reduction activities *within* parent companies and across facilities and analyze whether parents with a greater long-term debt dependence center their pollution abatement activities on facilities that are at higher risk of facing additional costs. This within-parent analysis accounts for differences in parent companies' time-varying financial conditions as well as exposure to environmental regulations and hence addresses concerns due to a potential selection bias. I continue to find that parents with a greater long-term debt dependence center their emission reduction activities on facilities that are at risk of facing additional costs to comply with environmental regulation.

My paper sheds light on the role of financial constraints on corporate environmental responsibility and thus contributes to the understanding of CSR investment. Using a large sample of firms from different countries, Ferrell et al. (2016) find that well-governed firms engage more in CSR, indicating that firm characteristics are important drivers for CSR. In a study of firms across 114 different countries Liang and Renneboog (2017) find that a country's legal origin is strongly correlated with a firm's CSR rating. My analysis contributes to this work by presenting evidence of the causal effect of financial constraints on a firm's engagement in socially responsible behavior, specifically the firm's focus on reducing toxic emissions. In addition to my results at the firm-level

I present evidence at the plant-level, showing that pollution decreases following the alleviation of of financial constraints.

Furthermore, my finding contributes to research examining the role of finance for the environment. Levine et al. (2018) finds that positive credit supply shocks by banks due to surprise discovery of shale gas (Gilje et al., 2016) reduces pollution. My results complement these findings by highlighting the role of financial constraints for firm pollution. Moreover, my findings also inform work, studying firms' pollution behavior. Harrison et al. (2015) finds that changes in environmental regulation reduce aggregate pollution in India and the share of large establishments that invest in pollution control increases. Analyzing within-product changes using a quantitative model, Shapiro and Walker (2017) finds that changes in environmental regulation contribute mostly to the reduction in overall emissions in the U.S. While work in this field centers on the effect of regulation for pollution, I focus on the role of financial constraints for emissions.

The remainder of this paper is organized as follows: Section 2 discusses the MEP and its impact on firm value and behavior. Section 3 provides hypotheses regarding the impact of the MEP on corporate environmental responsibility and introduces data sources, empirical strategy and sample. Section 4 presents regression results of the impact of the MEP on corporate environmental responsibility and the emission of toxic chemicals at the facility level. Section 5 analyzes the implementation of activities to reduce emissions. Section 6 concludes.

2 The Maturity Extension Program

2.1 Background

As a response to the Financial Crisis of 2007-09, the Federal Reserve engaged in expansionary monetary policy and reduced its target for the federal funds rate dramatically since August 2007. By the end of 2008, the Federal Open Market Committee (FOMC) arrived at a target federal funds rate of 0 to 25 basis points - an effective lower bound for conventional monetary policy. In addition to providing liquidity assistance to financial institutions as the lender of last resort, the Federal Reserve also started to engage in large scale asset purchases in November 2008 with a program to purchase direct obligations of housing related to government-sponsored enterprises.

The Federal Reserve extended this first Quantitative Easing (QE) program in March 2009, bringing its total purchases of mortgage-backed securities up to $1.25 trillion in 2009. Furthermore, the FOMC decided to also purchase up to $300 billion of Treasury securities. In November 2010 the Federal Reserve announced a second QE program with the intent of purchasing about $600 billion of Treasury securities by the end of mid-2011.

On September 21, 2011 the Federal Reserve announced the maturity extension program (MEP), its third (and final) QE program. In contrast to earlier programs, the Federal Reserve planned to purchase $400 billion of Treasury securities with remaining maturities of 6 years to 30 years and to sell, over the same period, a value of Treasury securities with remaining maturities of 3 years or less. This was implemented to extend the average maturity of the Federal Reserve's holding of securities and to "put downward pressure on longer-term interest rates and help make broader financial conditions more accommodative" (Federal Reserve System, 2011). In June 2012, the FOMC announced the continuation of the program through the end of 2012, resulting in the purchase of an additional $267 billion in Treasury securities.

2.2 Effects of the Maturity Extension Program

Empirical evidence regarding the causal impact of the Federal Reserve's QE policies in general, and the role of the MEP in particular, on yields is scarce and mixed. Abrahams et al. (2016), for instance argue that a reduction of real term premia contributed to lower yields when QE programs were announced. Weale and Wieladek (2016) argues that large scale asset purchase programs in the U.S. reduced long-term interest rates and household uncertainty, contributing positively to economic activity. Focusing on the MEP, Meaning and Zhu (2012) argues that the MEP had an effect on the long-term Treasury bond yield. Greenwood et al. (2014), on the other hand, posit that the Treasury's decision to increase the average maturity partially offset the effect of the MEP on the real economy. Focusing on spillover effects of the QE programs on corporate bond yields, Krishnamurthy and Vissing-Jorgensen (2013) also find little evidence that the MEP affected aggregate corporate bond yields.

Foley-Fisher et al. (2016) hypothesize that - due to the MEP's focus on purchasing long-term Treasury securities - the MEP should particularly benefit firms that are more dependent on long-term debt. Since the MEP reduces the market supply of long-term Treasury securities, the costs of issuing long-term debt should decrease if bond markets are partially segmented and demand for long-term securities is inelastic. Non-financial firms should respond to this by issuing long-term bonds to fill the gap in debt markets (Vayanos and Vila, 2009; Greenwood et al., 2010).

Foley-Fisher et al. (2016) finds that non-financial firms with a greater dependence on long-term debt benefit from the MEP. Specifically, they show that these firms experience higher abnormal returns following the announcement of the MEP. Moreover, Foley-Fisher et al. (2016) shows that firms with a greater dependence on long-term debt fill the gap in bond markets as they issue public debt. Moreover, firms that were more affected by the MEP grow more following the MEP, indicating that the MEP had real effects.[7]

[7] In 2016 the ECB engaged in a similar QE program as it decided to purchase public corporate debt of European firms. Grosse-Rueschkamp et al. (2018) examines the real effects of this program and finds evidence of real effects of this QE program in Europe.

3 Financial constraints and corporate social responsibility

3.1 Hypothesis development

Whether the relaxation of financial constraints boosts a firm's socially responsible investments depends on the motive for firm managers to engage in CSR investment. Greater investment in socially responsible behavior may maximize firm value (Edmans, 2011). Moreover, greater CSR investment may boost a firm's social capital, allowing the firm to obtain (cheaper) financing when markets experience a trust crisis as occurred during the financial crisis (Lins et al., 2017; Amiraslani et al., 2018). Firm specific characteristics, such as a corporation's geographic spread or its financial health may also affect managers' CSR investments. Examining firm specific determinants, Ferrell et al. (2016) finds that well-governed firms tend to exhibit greater CSR. Alleviating financial constraints may therefore allow firms to also increase their CSR investment.

Earlier work presents evidence that investments in pollution reducing activities are typically large and upfront and provide little cost-savings potential. For instance, Fowlie et al. (2015) evaluates households' investment into energy efficient measures and finds that upfront costs are about twice as large as total energy savings. Walker (2013) finds large macroeconomic costs when firms need to comply with (new) environmental regulations as workers in newly regulated industries experience a large shock to their earnings. Similarly, findings by Greenstone et al. (2012) show that air quality regulations reduce manufacturing plants' total factor productivity. If financial conditions improve, firms may therefore find it optimal not to invest in measures to reduce emissions. Moreover, an expansion of firm operations using an unaltered production process may result in an increase in toxic emissions if firms expand their activities once financial constraints relax.

Violating environmental regulations, on the other hand, can be very costly (Greenstone, 2002; Walker, 2011; Shapiro and Walker, 2017), providing incentives for firms to focus on reducing toxic emissions to ensure that they comply with environmental regulations. Better financial conditions may thus allow a firm to undertake investments into emission reducing activities, resulting in a cleaner production process and lower toxic emissions. Thus, depending on the trade-off between costs and benefits of emission reduction investments the alleviation of financial constraints may lead to a reduction in emissions.

3.2 Identification strategy

Earlier work by Foley-Fisher et al. (2016) finds that the MEP reduced financial constraints, particularly for firms with a greater dependence on long-term debt. Since the MEP put downward pressure on long-term interest rates it specifically relaxed financial constraints for firms dependent on long-term debt. Moreover, the MEP was unexpected as Foley-Fisher et al. (2016) find that affected firms' abnormal returns as well as intra-day returns increase following the Federal Reserve's announcement of the MEP. Exploiting heterogeneity in firms' exposure to the shock due to the MEP I examine whether the alleviation of financial constraints affects firms' focus on environmental social responsibility and their pollution.

3.3 Data sources

3.3.1 Sources

I gather information on companies' corporate social responsibility from Thomson Reuters. Thomson Reuters provides information on a variety of environmental, social and governance (ESG) factors for over 6,000 companies worldwide. To construct these measures, Thomson Reuters uses public reporting (e.g. annual reports, corporate social responsibility reports, websites, global media sources) and standardizes the information.

Plant-level information regarding the emission of toxic chemicals are provided by the Toxic Release Inventory (TRI), compiled by the U.S. Environmental Protection Agency (EPA). The TRI reports toxic chemical releases by industrial and federal facilities for the United States.[8] Federal facilities as well as industrial plants that (1) belong to a specific industry (manufacturing, mining, electric power generation, and hazardous waste treatment), (2) employ more than ten full-time equivalent employees and (3) use a TRI-listed chemical exceeding a certain threshold need to file TRI reports with the EPA on an annual basis.[9] Specifically, facilities need to self-report storage and release of more than 650 TRI-listed chemicals. In addition to information on the annual total emission of a chemical, TRI also reports information on the plant's name, physical location and the parent company's name. I use data on the employment size of plants, provided by the University of Wisconsin's Business Dynamics Research Consortium (BDRC).

3.3.2 Variable definitions

Firm-level: Environmental Responsibility I use information from Thomson Reuters regarding a firm's corporate responsibility. Thomson Reuters relies on several publicly available sources, such as company reports, stock report filings, and news and measures a firm's performance, commitment and effectiveness towards addressing issues related to the environment (E), the firm's relationship with employees, customers, suppliers and communities (S) and performance of the firm's governance (G).

[8]The collection of this information was mandated by the U.S. Emergency Planning and Community Right-to-Know Act of 1986 with the aim of helping communities plan for chemical emergencies.

[9]The chemicals that need to be reported are considered to cause (a) cancer or other chronic human health effects, (b) significant adverse acute human health effects, or (c) significant adverse environmental effects.

These ESG scores report a firm's relative ranking with respect to other firms as a percentile ranking. In the analysis I primarily focus on firms' Environmental Score, which captures a firms relative ranking regarding its overall focus on the environment. In further tests I examine the firm's total ESG score, its social and governance score. To limit the influence of outliers, I exclude the top and bottom 1 percent of the Scores from the sample.

Facility-level: Total release of toxic chemicals Plants in the U.S. need to report for each TRI-listed chemical the total quantity released as well as the type of release. I focus on chemicals, commonly reported and listed in Section 313 of the Emergency Planning and Community Right-to-know Act and use the total on-site release of a plant's chemical in a year as the main variable in my analysis. To mitigate the effect of outliers, I take the natural logarithm of the total releases for a chemical and exclude the top 1 % of the sample.

Hazardous pollutant concentration In robustness tests I use information on the concentration of hazardous pollutants in the air. Information on the concentration of hazardous pollutants is provided in the EPA's Air Quality Index (AQI) data. The annual AQI data reports for each monitoring station annual concentration levels (e.g. arithmetic mean, different percentiles, etc.) of several hundreds hazardous pollutants. I focus on the five most common hazardous pollutants, i.e. carbon monoxide, nitrogen dioxide, ozone as well as fine and coarse particulate matter. My measure of pollution is a hazardous pollutant's average, median as well as 90th percentile concentration level within a year.

Long-term debt dependence I follow Foley-Fisher et al. (2016) and consider a firm's long-term debt to consist of debt with a maturity at issuance longer than one year, scaled by total debt:

$$\text{Long-term debt dependence} = \frac{\text{Debt with a maturity at issuance longer than one year}}{\text{Total debt}} \tag{1}$$

Similar to Foley-Fisher et al. (2016) I calculate the historical average of this ratio prior to 2007 to limit the influence of the the financial crisis on this measure. In robustness tests I examine the sensitivity of my results to alternative definitions of long-term debt dependence.

Control variables I control for a firm's book-to-market value, total debt (scaled by assets), return-on-assets, income-over-assets, Tobin's q, capital-intensity (depreciation, scaled by lagged assets) and short-term financing needs (difference between receivables and payables, scaled by total sales) in the regression analysis (Foley-Fisher et al., 2016). Furthermore, I control for differences in plants' size using the natural logarithm of total plant employment.

3.4 Empirical Strategy and Descriptive Statistics

3.4.1 Firm-level analysis

In the first step of my analysis I examine changes in a firm's corporate social responsibility by analyzing the differential effect of the MEP on a firm's ESG score. Specifically, I estimate the following regression model:

$$E_{f,t} = \beta LTD_f \cdot MEP_t + \mathbf{X'}_{f,t}\gamma + \alpha_f + \alpha_{i,t} + \epsilon_{c,t}, \tag{2}$$

where $E_{f,t}$ is firm f's Environmental Score in year t, LTD_f is f's long-term debt dependence, MEP_t is a dummy variable taking on the value of one after the implementation of the MEP, i.e. 2011, $\mathbf{X'}_{f,t}$ is a set of firm control variables, α_f and $\alpha_{i,t}$ are firm and industry-specific (SIC 2-digit) year fixed effects, respectively.

The coefficient of interest is β which captures the differential effect of the MEP on a firm's Environmental Score due to its long-term debt dependence. A positive estimate of β thus indicates that firms with a greater exposure to the MEP increase their corporate environmental responsibility more following the implementation of the MEP.

3.4.2 Plant-level analysis

Firm-level information on the total release of toxic chemicals is not publicly available and hence I examine whether the MEP is followed by a reduction in toxic emissions at facilities that belong to parent companies with a greater long-term debt dependence. In particular, I estimate the following regression model:

$$ln(y_{c,p,i,l,t}) = \beta LTD_f \cdot MEP_t + \mathbf{X'}_{p,t}\gamma + \alpha_{c,p} + \alpha_t/\alpha_{i,t}/\alpha_{i,c,t}/\alpha_{l,t}/\alpha_{c,t} + \epsilon_{c,p,i,l,t}, \quad (3)$$

where $ln(y_{c,p,i,l,t})$ is the natural logarithm of total releases of chemical c by plant p, involved in industry i, located in county l in year t, LTD_f is the long-term dependence of a plant's parent company f, MEP_t is an indicator variable taking on the value of one for the years after the MEP, $\mathbf{X'}_{p,t}$ are a set of firm-level and plant-level control variables, $\alpha_{c,p}$ is a chemical-plant fixed effects and $\alpha_t/\alpha_{i,t}/\alpha_{i,c,t}/\alpha_{l,t}/\alpha_{c,t}$ are year/industry-year/industry-chemical-year/county-year/chemical-year fixed effects.

The coefficient of interest is β, which captures the average relative difference in toxic emissions following the MEP for plants belonging to parent companies with a greater long-term debt dependence. A positive estimate of β indicates that plants that belong to parent companies with a greater exposure to the MEP reduce toxic emissions more following the MEP.

To account for unobservable characteristics, such as changes in total emissions of certain chemicals due to business cycles or differences in regulations, I include additional fixed effects in the analysis. Specifically, I include county-year, chemical-year, industry-year, industry-chemical-year as well as industry-chemical-county-year fixed effects in the analysis. These fixed effects capture unobservable time-varying effects at the location-, industry- or chemical-level of the plant and therefore allow a me to account for unobservable time-varying influences on toxic emissions.

3.5 Sample construction and descriptive statistics

3.5.1 Firm-level sample

I use CUSIPs to match firms, reported in Compustat, to the information on CSR reported by Thomson Reuters. Balance sheet information on companies is provided by Compustat. I exclude all firms that are involved in the Finance, Insurance and Real Estate sector (SIC codes 6000 to 6999). The final sample thus consists of publicly traded firms in the U.S. that (a) are not financial firms (SIC Code 6000 - 6999) and (b) can be matched to Thomson Reuters's Score. There are 1,306 firms in my sample and the sample covers the years 2006 to 2016. Panel A of Table 1 reports descriptive statistics of the firm-level sample. On average 87 percent of a firm's total debt has a maturity of more than one year. Furthermore, a firm's average environmental responsibility, as measured by the Environmental score is 53.

3.5.2 Plant-level sample

The TRI provides information on the parent company's name and I use that information to hand-match plants to their parent companies. I identify 910 parent companies and 9,978 unique plants.[10] These 9,978 plants are responsible on average for about half of the annual emission of toxic chemicals in the U.S.. The plant-level sample covers the years 2006 to 2016. The University of Wisconsin's BRDC provides plant-level information on employment. Panel B of Table 1 reports descriptive statistics of key variables at the plant-level. On average a plant reports releasing about 30,000 pounds of a chemical every year. Moreover, there is considerable heterogeneity in plant size and the average plant employs about 264 employees.[11]

4 Results

4.1 Firm-level analysis: Maturity Extension Program and corporate environmental responsibility

4.1.1 Average effect

Regression results from estimating regression (2) are reported in Table 2 where standard errors are clustered at the firm level. The positive and statistically significant coefficient on the interaction of the MEP-dummy and the firm's average long-term debt dependence indicates that firms with a greater dependence on long-term debt improve their corporate environmental responsibility more following the MEP. This effect also holds when I add (a) further firm control variables in column (2) and (b) industry (SIC 2-digit)-year fixed effects to capture unobservable changes at the industry-level in column (3). Thus, even conditioning on time-varying differences in the Environmental Score across firms within the same industry, I find that firms that were more affected by the MEP increase their focus on the environment.

[10] In total there are 32,811 unique plants in the TRI and hence I am able to identify public parent companies for about 30% of those. On average a plant reports 5 different chemicals and 30 % of all plants report only one chemical.

[11] Unfortunately the employment information for the BRDC is only available for 6,064 plants.

To examine the sensitivity of this finding with respect to the definition of long-term debt dependence I modify the main independent variable. Since the MEP was aimed at maturities above and beyond three years, I first calculate a firm's long-term debt dependence by dividing a firms' debt with remaining maturity above three years by its total debt.[12] Second, I modify the calculation of a firm's long-term debt dependence and also include the period after the financial crisis. Thus far, my main measure of long-term debt dependence is computed using information up until 2007, i.e. the onset of the financial crisis. The financial crisis, however, may have also changed firms' long-term debt dependence and hence also their exposure to the MEP in 2011. To address this, I use information up until 2010 when calculating a firm's long-term debt dependence and re-estimate the earlier regression model.

Columns (4) to (6) of Table 2 report regression results where I evaluate the earlier findings using these two alternative measures of long-term debt dependence. Across the different definitions of long-term debt dependence, I find that firms with a higher long-term debt dependence improve their focus on the environment following the MEP. This effect is statistically significant across all employed measures of long-term debt dependence, suggesting that my results are not driven by the definition of long-term debt dependence. Economic magnitudes are also quite sizeable: using the coefficient from column (3) I find that a one standard deviation increase in a firm's long-term debt dependence increases its corporate environmental responsibility by about 1 percentage point.

4.1.2 Other dimensions of corporate social responsibility

The results indicate that firms that were more exposed to the MEP increase their focus on the environment following the MEP. A firm's environmental responsibility is part

[12]Information on debt reporting in Compustat becomes unreliable as maturities increase. The online appendix in Foley-Fisher et al. (2016) provides a further discussion on this.

of a corporation's overall social responsibility strategy. To examine whether firms with a greater long-term debt dependence also display in increase in their overall corporate social responsibility, I estimate regression model (2) where I replace the dependent variable with a firm's overall ESG score. Regression results are reported in Panel A of Table 3. For expositional purpose I only report results from the most restrictive empirical specification, i.e. the empirical specification with firm and industry-year fixed effects and the full set of control variables. Results are qualitatively similar using the other specifications as well as alternative independent definitions of long-term debt dependence. The positive and statistically significant coefficient on the interaction between long-term debt dependence and the MEP dummy indicates that the boost in firm's environmental responsibility also translates into greater overall corporate social responsibility.

In Panel B of Table 3 I further explore whether the MEP is also followed by an increase in the other two areas of corporate social responsibility, i.e. Social and Governance. Using Thomson Reuters's Social or Governance Score as the dependent variable, however, I do not find that the MEP is followed by an increase in these corporate social responsibility criteria. This shows that firms that are more exposed to the MEP only increase their focus on the environment following the MEP.

A firm's Environmental Score is based on three individual subscores. Specifically, Thomson Reuters captures a company's focus on the environment using three different scores regarding (1) the company's emission reduction efforts ("Emissions"), (2) its use of materials, energy or water ("Ressource Use") and (3) its innovation activity in environmental technologies ("Innovation"). Using these three scores as the dependent variable, I find that greater exposure to the MEP leads to a significant increase for the scores capturing a firm's focus on reducing emissions ("Emissions") and a firm's improvements in the use of resources ("Ressource Use"), respectively (Panel C of Table

3). This indicates that the overall improvement in a firm's ESG score is due to a greater focus on the environment, particularly a focus on reducing emissions and improving the efficient use of materials, energy or water.

4.1.3 Dynamic effects

The results show that firms with a greater long-term debt dependence increase their focus on the environment following the MEP. In particular, firms focus on reducing emissions and improving their use of ressources. I now examine the dynamic effects of the MEP by analyzing the evolution of the "Emissions" and "Ressource Use" score before and after the MEP. Specifically, I estimate the following regression model:

$$E_{f,t} = \sum_{j=2006}^{2016} \alpha_j (D_j \cdot LTD_f) + \mathbf{X'}_{f,t}\gamma + \alpha_{i,t} + \alpha_f + \epsilon_{f,t}, \tag{4}$$

where $E_{f,t}$ is either the "Emissions" or "Ressource Use" score of firm f in year t; D_j is a dummy variable, taking on the value of one in year j and zero otherwise; LTD_f is the corporation's long-term debt dependence; $\mathbf{X'}_{f,t}$ are a set of firm-level control variables, α_f and $\alpha_{i,t}$ are firm and industry-specific (SIC 2-digit) year fixed effects, respectively. The coefficients α_j represent the differential effect of a firm's greater long-term debt dependence on the "Emissions" and "Ressource Use" Score, respectively, in year j. For instance, α_{2012} estimates the effect of a firm's long-term debt dependence on the "Emissions" or "Ressource Use" Score in 2012. The differential effect on the score in 2011, i.e. the MEP-year, is dropped due to collinearity from the analysis. Thus, the coefficients α_j are relative to the year of the MEP.

Figure 1 plots the estimated coefficients α_j as well as the 95% confidence interval for the coefficients obtained from estimating regression model (4). The dynamic pattern in Figure 1 shows that there is no significant differential effect of a firm's long-term

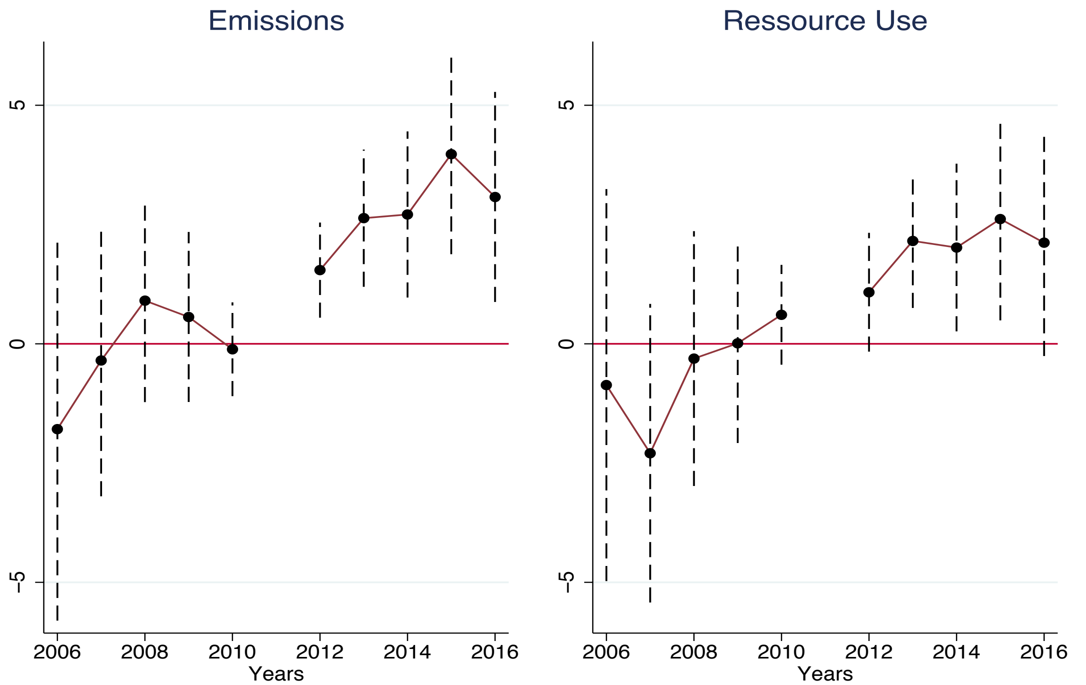

Figure 1: Exposure to the MEP and "Emission" and "Ressource Use" score

debt dependence on its "Emissions" and "Ressource Use" Score in the years prior to the MEP. Following the MEP, however, firms with a higher long-term debt dependence display a boost to their "Emissions" and "Ressource Use" Score. Specifically, the dynamic pattern of the "Emissions" Score suggests that the MEP had a first-order and long-lasting effect on companies' focus on reducing emissions.

4.2 Plant-level analysis: Maturity Extension Program and total toxic emissions

The positive and statistically significant coefficient in Table 3 indicates that corporations that are more exposed to the MEP increase their focus on the environment by reducing emissions. This result is robust to the inclusion of additional fixed effects and not sensitive to the definition of long-term debt dependence. The dynamic pattern, represented in Figure 1 further shows that (a) there is no differential effect of long-term debt dependence on a firm's focus on the environment prior to the MEP and that (b) the MEP had long-lasting effects on firms' focus on emission reduction.

I now utilize micro-level information regarding the release of toxic chemicals at the facility level and examine whether the MEP is followed by a reduction of toxic emissions at the facility-level. Since the TRI provides information regarding the total emission of toxic chemicals at the plant-level, this analysis complements the firm-level analysis. As such it not only provides a validation of the earlier results, but also delivers insights by evaluating micro-level changes in toxic emissions.

Table 4 reports regression results from estimating equation (3) where standard errors are robust and clustered at the chemical-year level.[13] The reported coefficients in Table 4 are standardized and represent economic magnitudes, i.e. the estimated coefficient β represents the number of standard deviations emissions change with a one standard deviation increase in the parent company's long-term debt dependence.

The negative and statistically significant coefficient in column (1) of Table 4 indicates that plants that belong to parent companies with a greater long-term debt dependence reduce their emissions more following the MEP. This also holds after including the firm-level control variables as well as controlling for a plant's size using the natural logarithm of the plant's total employment.[14]

Note that the TRI provides a break-down of total releases by chemical and thus the unit of observation is a plant-chemical pair. Regression model (3) accounts for time-invariant differences at the unit of observations by including plant-chemical fixed effects. The coefficient β therefore represents the average change in the release of a

[13] Regression results are also robust to clustering standard errors at the plant or plant-chemical level. Clustering at the chemical-year level, however, allows for correlation of toxic emissions within a chemical and year across all plants.

[14] Information on plants' employment is only available for about 60 percent of all plants in my sample. This unfortunately reduces the sample size for the analysis. All results are qualitatively similar, however, if I only use firm-level control variables.

chemical within a plant. To evaluate the robustness of my finding, I augment the regression specification with additional fixed effects. Specifically, I allow for variation in the emissions of chemicals over time by including chemical-year fixed effects in column (3). Moreover, I include industry-year- and county-year fixed effects to capture unobservable time-varying differences at the industry- and county-level. Again, I find that the MEP is followed by lower emissions for plants belonging to parent companies that depend more on long-term debt (column 4). In column (5) I further allow for variation in the emission of toxic chemicals across industries by including industry-chemical-year fixed effects. I continue to find that plants that belong to parents that are more exposed to the MEP reduce toxic emissions more following the MEP. Finally in column (6) I allow for heterogeneity in the time-varying chemical fixed effects at the industry-level across counties. Thus, the coefficient on the interaction between long-term debt dependence and the MEP dummy is identified by comparing emissions of the same chemical across plants belonging to different parent companies, but involved in the same industry-sector and located in the same county. This set of fixed effects reduces the sample size to about a quarter since only a few counties have more than one plant belonging to different industries. However, even with this restrictive set-up I continue to find that plants belonging to a parent company with a greater long-term debt dependence reduce toxic emissions more following the MEP.[15]

The reported coefficients in Table 4 are standardized and thus display economic magnitudes. The coefficient from column (5) for instance shows that following the MEP, the level of toxic emissions falls by about 1 percent of its sample standard deviation if the long-term debt dependence of the parent company increases by one standard deviation. These findings are consistent with the earlier results from the firm-level analysis. Moreover, by analyzing toxic emissions, I find that the MEP was

[15]These results are not sensitive top the definition of long-term debt dependence.

followed by a reduction in pollution for firms that were more exposed to the MEP. Since the MEP put pressure on long term interest rates, this finding is consistent with the idea that the MEP reduced financial constraints, allowing them to reduce toxic emissions.

4.3 Robustness

4.3.1 Common chemicals

The TRI requires plants to provide information of the total release of several hundred different chemicals. Some of these chemicals are not very common in the production process and hence are not often reported. Although the plant-chemical fixed effects account for heterogeneity in the prevalence of chemicals, differences in the production across plants, regions or time still affect my results.

To examine the robustness of my findings, I now restrict attention to chemicals that are widely used over the sample period and focus on the 40 (20) most common chemicals in my sample, i.e. the 40 (20) most often reported chemicals. Table 5 reports regression results from estimating regression equation (3) using these subsamples. Similar to before I find that the interaction between a firm's long-term debt dependence and the MEP dummy is negative and statistically significant. This suggests that my findings are not driven by changes in the emissions of a few chemicals.

4.3.2 Hazardous pollutants from monitor readings

The TRI provides self-reported information on the release of toxic emissions and thus is subject to a self-reporting bias. To assess the sensitivity of my finding, I examine whether the MEP is associated with a decrease in measured pollution, tracked by air quality monitors.

To gauge air quality, the EPA uses information from air quality monitoring stations across the U.S. Different to the TRI, which reports toxic emissions of chemicals, the monitoring sites track the level of hazardous airborne pollutants, i.e. pollutants that cause adverse environmental effects across a year. Information on the level of these pollutants at the monitor level are provided by the EPA in the Air Quality Index (AQI) reports. The AQI data report for each monitor and pollutant percentiles regarding the concentration of different hazardous pollutants within a year. This information is not self-reported by plants but based on objective recordings of the concentration of hazardous pollutants at monitors.

The EPA provides information for about 1,800 monitoring sites over the time period 2006 to 2016. These sites are located across the country and hence are exposed to different plants. To account for this, I first compute the distance between a monitoring site and plants using information on the location (longitude and latitude) of plants and monitors. Considering all plants within a twenty miles radius around the monitor's location I then compute for each monitor the distance weighted average level of all plants' long-term debt dependence.[16] I then estimate the following regression model:

$$ln(e_{p,m,c,t}) = \beta L\bar{T}D_m \cdot MEP_t + \alpha_{m,p} + \alpha_{p,t}/\alpha_{c,p,t} + \epsilon_{m,p,c,t}, \quad (5)$$

where $ln(e_{p,m,c,t})$ is the natural logarithm of hazardous pollutant p's level,[17] recorded by monitor m, located in county c in year t; $L\bar{T}D_m$ is the average level of long-term debt dependence of all plants within a 20 miles radius around monitor m; MEP_t is a dummy variable, taking on the value of one after the MEP, $\alpha_{m,p}$ is a pollutant-monitor fixed effect and $\alpha_{p,t}/\alpha_{c,p,t}$ are pollutant-year/pollutant-county-year fixed effects. The coefficient β captures the differential change in hazardous pollutants' concentration

[16]Similar to Currie and Neidell (2005) and Schlenker and Walker (2016) I use inverse distances to aggregate the information.

[17]I focus on the following five important pollutants: Carbon Monoxide, Lead, Nitrogen Dioxide, Ozone, Sulfur Dioxide, Particulate Matter smaller than 2.5 micrometers and Particulate Matter smaller than 10 micrometers.

due to differences in plants' average long-term debt dependence following the MEP.

Table 6 reports regression results from estimating model (5) where standard errors are robust and clustered at the monitor-pollutant level. The negative and statistically significant estimate of β shows that the concentration of hazardous pollutants decreases more for monitors that are closer to plants, belonging to parent companies with a greater long-term debt dependence following the MEP. The finding remains when I include county-pollutant-year fixed effects and hence compare pollutant concentrations across monitors within the same county and year, but monitors differ in their distance to plants with parent companies that have a greater long-term debt dependence. Again, I find that pollution decreases more in areas where plants are exposed to the MEP more. This is consistent with the earlier findings and suggests that my results are not driven by biases due to plants' self-reporting of pollution.

5 Maturity Extension Program and emission reduction investments

5.1 Average effect

The results show that plants, belonging to parent companies that were more exposed to the MEP, reduce toxic emissions more than other plants. Furthermore, I also find that the concentration of hazardous pollutants decreases more in areas with plants that belong to parent companies with a greater long-term debt dependence. Since the MEP reduces funding costs for long-term debt, these results are consistent with the idea that (1) the MEP alleviated financial constraints for firms with a greater long-term debt dependence, and (2) the relaxation of financial constraints allows firms to increase their focus on emission reduction.

In addition to information regarding the quantity of toxic emissions, the TRI also reports whether a plant implements measures to reduce pollution. Specifically, facilities report if they undertake activities to reduce emissions of a specific chemical. These activities can take different forms[18] and an example of how a plant reduces emissions is the change in the production process of the aircraft manufacturer Boeing: Boeing reports in 2016 that it added valves to allow separation of contaminated trichloroethylene (TCE) from clean TCE, which allows longer use of the remaining TCE and reduces emissions.

On average about 12 percent of all plants in the sample report source reduction activities every year. To examine whether plants invest in activities to reduce toxic emissions, I use information from the TRI and define a dummy variable, taking on the value of one whether a facility reports pollution abatement investments. Using this dummy variable as the dependent variable I then examine whether facilities that were more affected by the MEP are more likely to implement emission reduction activities.

Table 7 presents regression results from estimating regression model (3), but using the aforementioned dummy variable as the dependent variable. While the coefficient on the interaction between long-term debt dependence and the MEP dummy in column (1) is not statistically significant at the 10 percent level, I find that this effect becomes more pronounced and statistically significant once I include additional fixed effects. Similar to before, I add county- and industry-chemical-fixed effects in columns (2) and (3), respectively and find that a greater long-term debt dependence boosts firms' pollution abatement investment. Further, I find that this effect is robust to the inclusion of county-industry-chemical-year fixed effects as indicated by the significant and positive coefficient on the interaction between long-term debt dependence and the MEP dummy

[18] In particular, facilities can report whether they implement activities and reduce emissions due to (a) good operating practices, (b) process modifications, (c) inventory control, (d) spill and leak prevention, (e) cleaning and degreasing, (f) surface preparation and finishing or (g) product modifications.

in column (4).

In columns (5) to (8) I examine the robustness of my finding and focus (similar to Table 5) on the 20 most common chemicals.[19] Using this subsample, I find that firms with a greater exposure to the MEP implement activities to reduce toxic emissions across all specifications. This suggests that firms center their pollution abatement investments on chemicals commonly emitted as part of the production process.

Since the dependent variable is a dummy variable, the coefficients reported in Table 7 represent changes in the likelihood to enact emission reduction activities. Thus, considering the coefficient from column (4), for instance, I compute that a one standard deviation increase in a parent's long-term debt dependence increases facilities' likelihood of implementing activities to reduce toxic emissions by about 1.21 percentage points. The unconditional average probability of implementing emission reduction activities is 3 percent (Table 1) and thus, the MEP increases the likelihood of investing in pollution abatement by about 40 percent. Together with the earlier finding that plants also reduce toxic emissions, the results suggest that the MEP particularly led to a reduction in toxic emissions as it allows plants to implement pollution reduction activities.

5.2 Differential effect

The findings in Table 7 show that firms that are more exposed to the MEP are also more likely to implement pollution abatement measures. To examine this finding further, I now analyze whether the investment in activities to reduce emissions differs whether plants are at risk of facing additional - monetary or reputational - costs due to pollution.

[19] Results are qualitatively similar when I focus on the 40 most common chemicals.

Specifically I modify the earlier analysis and estimate the following regression model:

$$
\begin{aligned}
R_{c,p,i,l,t} = \beta_1 LTD_f \cdot MEP_t + \beta_2 MEP_t \cdot F_p + \beta_3 LTD_f \cdot MEP_t \cdot F_p + \\
+ \mathbf{X'}_{p,t}\gamma + \alpha_{c,p} + \alpha_{c,g,t} + \alpha_{i,t}/\alpha_{l,t}/\alpha_{c,t}/\alpha_{i,c,t}/\alpha_{i,c,l,t} + \epsilon_{c,p,i,l,t},
\end{aligned} \quad (6)
$$

where $R_{c,p,i,l,t}$ is an indicator variable, taking on the value of one whether plant p located in county l reports activities to reduce toxic emissions for chemical c in year t, or zero otherwise, LTD_f is the long-term dependence of the plant's parent company f, MEP_t is an indicator variable taking on the value of one for the years following the MEP, F_p is an indicator variable taking on the value of one if plant p is at risk of facing additional costs due to pollution (see below), $\mathbf{X'}_{p,t}$ are a set of firm- and plant-level control variables, $\alpha_{c,p}$ is a chemical-plant fixed effect, $\alpha_{g,c,t}$ is a group-chemical-year fixed effects[20] and $\alpha_{i,t}/\alpha_{l,t}/\alpha_{i,c,t}/\alpha_{i,c,l,t}$ are industry-year/county-year/industry-chemical-year/industry-county-chemical-year fixed effects. The coefficient of interest is β_3, i.e. the coefficient on the triple interaction between (1) a parent's long-term debt dependence, (2) the MEP dummy and (3) an indicator variable, taking on the value of one whether the plant belongs to a group of plants that are at risk of facing additional costs due to pollution (see below). This coefficient captures the differential effect of a parent's greater long-term debt dependence on the implementation of emission reduction activities following the MEP across plants.

5.2.1 Plants with (prior) enforcement actions

The EPA also enforces environmental laws and typically works with state regulators to ensure that facilities comply with the Clean Air Act, the Resource Conservation and Recovery Act and the Safe Drinking Water Act. As part of their enforcement

[20] The respective group is defined below.

tools, the EPA and state regulators can take criminal or civil enforcement actions against facilitates that violate environmental laws. Civil enforcement actions can be distinguished into non-judicial enforcement actions and judicial actions. Non-judicial enforcement actions are administrative actions taken by the EPA or a state regulator under its own authority. These actions take the form of a notice of violation or an order directing an individual, a business, or other entity to take action to come into compliance. Civil judicial actions are formal lawsuits, filed by the U.S. Department of Justice on behalf of the EPA or by a state's attorney general on behalf of the state. Criminal enforcement actions are imposed by a judge at the sentencing and are usually reserved for the most serious violations.[21]

The EPA provides information regarding their enforcement actions and facilities' compliance with regulatory standards in their Integrated Compliance Information System (ICIS), which tracks formal administrative and judicial enforcement actions. These data report for every enforcement case detailed information regarding the date and type of violation as well as whether the case was enforced using administrative or judicial activities. Via an online-tool the EPA also provides detailed information regarding the violation of environmental regulations on its website.[22]

Enforcement actions and fines tend to decrease firm value: using a sample of publicy traded firms in the U.S. Karpoff et al. (2005) and Badrinath and Bolster (1996) find that legal penalties due to the violation of environmental laws significantly reduce firm value. Examining the link between environmental performance and firm value, Konar and Cohen (2001) finds that a firm's bad environmental performance is associated with a lower value of intangibles, indicating that the stock market values a firm's environmental performance. In addition to monetary penalties, the enactment of enforcement

[21] The EPA provides detailed information regarding ongoing enforcement actions, guidelines and legal background on its website (http://www.epa.gov/enforcement).

[22] This is made available via the EPA's Enforcement and Compliance History Online System (http://echo.epa.gov).

actions against firms may also trigger reactions by communities, that induce firms to implement pollution abatement investments (Pargal and Wheeler, 1996). Enforcement actions are also followed by increase oversight and scrutiny by regulators (Evans and Stafford, 2018).

Enforcement actions thus represent a shock to firms as they reduce firm value or hurt a firm's reputation. Thus, I hypothesize that firms that were subject to an enforcement action are more willing to implement emission reduction activities to come into compliance as the investment in pollution abatement measures can reduce a firm's likelihood of being subject to an enforcement action in the future. Moreover, reporting the implementation of measures to reduce toxic emissions may be an optimal response due to a communities' heightened interest in a firm's pollution behavior (Pargal and Wheeler, 1996) or due to state regulators' increased oversight activity (Evans and Stafford, 2018).

To examine this, I use information from the ICIS and define a dummy variable, taking on the value of one whether the plant was ever subject to an enforcement action in the five years prior to the MEP. The variable F_p (regression model (6)) thus takes on the value of one if plant p was ever subject to an administrative enforcement action in the five years prior to 2011.

Regression results from estimating regression model (6) are reported in Panel A of Table 8. The coefficient on the interaction between a parent's long-term debt dependence and the MEP dummy is positive, but not statistically significant. The coefficient on the triple interaction, however, is positive and highly significant. This indicates that the decision to implement activities to reduce toxic emissions primarily take place at plants that were subject to an enforcement action prior to the MEP. Moreover, I find that the average effect of the interaction between a facility's long-term debt dependence and the MEP dummy is only significantly different from zero for plants that were subject to an enforcement action prior to 2011. Plants, that have not violated regulatory standards, however, are not more likely to invest in activities to reduce toxic emissions.

This result is robust to the inclusion of additional fixed effects as I find that the estimated coefficient of β_3 is highly significant across all specification. This pattern is consistent with the idea that a relaxation of financial constraints (due to the MEP) allows plants to implement emission reduction activities, particularly if these plants are at higher risk of facing additional costs as they have previously violated environmental regulations.

5.2.2 Plants in areas with higher risk of regulatory intervention

To ensure that ambient air pollution is within the standards set forth in the Clean Air Act, the EPA utilizes several monitoring stations across the country. In case the air quality deteriorates due to the increase in hazardous pollutants the EPA may designate an area to be in non-attainment status. In case the level of hazardous pollutants exceeds the National Ambient Air Quality Standards (NAAQS) as defined in the Clean Air Act Amendments an area is considered be in non-attainment status.

While the NAAQS sets forth the air quality standards that have to be met, state and local governments are tasked with ensuring that (a) areas are in attainment status or that (b) areas in non-attainment status will develop and implement plants to ensure and maintain clean air standards. Specifically, states need to provide implementation plans to describe what measures will be taken to ensure compliance with the NAAQS. In case of non-attainment state implementation plans usually force firms to implement "lowest achievable emission rates", which represents a heavy financial burden on firms as it forces them to implement ways to reduce pollution (Becker, 2005). Greenstone (2002) and Walker (2011) find that economic output decreases once an area is considered to be in non-attainment status as industrial activity and employment shrinks. This suggests that firms face additional costs once they have to comply with air quality standards as environmental agencies force them to reduce emissions.

Since complying with air quality standard is costly, I hypothesize that plants are more likely to implement emission reduction activities once financial constraints relax if they are located in areas that are subject to stricter environmental oversight. Thus, I expect that the aforementioned effect of increasing source reduction activities is more pronounced for plants, located in counties that were (at least once) considered to be in non-attainment status prior to 2011.

Using information on the historical designation of counties from 2006 to 2011 from the EPA, I therefore first identify all counties where ambient air pollution for at least one pollutant exceeded the NAAQS at least once.[23] I then use the aforementioned regression model (6) and examine the differential effect of a firm's long-term debt dependence on the implementation of emission reduction activities and include the triple interaction between a firm's long-term debt dependence, the MEP dummy and a dummy variable taking on the value of one whether the plant is located in a non-attainment county.

Regression results are reported in Panel B of Table 8. Similar to before I find that a greater long-term debt dependence does not increase the average likelihood of implementing pollution abatement investments. While the coefficient on the triple interaction is positive, I do not find a statistically significant difference of the effect for facilities located in counties that were designated to be in non-attainment status prior to the MEP. Focusing on the average joint effect of a greater long-term debt dependence on the investment in pollution abatement measures, however, I find that the MEP only boosts the implementation of emission reduction activities for plants located in counties

[23]375 counties (out of 1,304 counties) in my sample were at least once in non-attainment status prior to 2011.

that were in non-attainment status prior to the MEP. This finding is robust to the addition of fixed effects and is consistent with the idea that plants in non-attainment counties respond to higher potential costs when a county is designated to be in non-attainment status. To prevent a possible reduction in output, the alleviation of financial constraints allows firms to implement pollution reduction activities particularly in these counties to avoid a possible negative effect if air quality in that county deteriorates again.

5.3 Pollution prevention activities - Within firms

The results in Table 8 show that activities to reduce emissions are primarily happening in (a) plants that were subject to an enforcement action prior to the MEP and (b) plants that are located in counties at higher risk of being considered to be in non-attainment status. This finding may, however, be subject to a selection bias: if, for instance, firms with a higher long-term debt dependence also operate more plants that were subject to an enforcement action, then the positive coefficient on the triple interaction may be driven by this selection.

Since I am exploiting heterogeneity within parent companies in the aforementioned analysis, however, I can account for this and examine how a greater exposure to the MEP affects a firm's focus to invest in pollution abatement activity *within the firm*. Specifically, I modify the earlier regression model (7) and also include firm-chemical-year fixed effects:

$$R_{c,p,i,l,t} = \beta LTD_f \cdot MEP_t \cdot F_p + ln(emp)_{p,t}\gamma + \\ + \alpha_{f,c,t} + \alpha_{c,p} + \alpha_{c,g,t} + \alpha_{i,t}/\alpha_{l,t}/\alpha_{c,t}/\alpha_{i,c,t}/\alpha_{i,c,l,t} + \epsilon_{c,p,i,l,t}, \quad (7)$$

where $R_{c,p,i,l,t}$ is an indicator variable, taking on the value of one whether plant p located in county l reports activities to reduce toxic emissions for chemical c in year t, or zero otherwise, LTD_f is the long-term dependence of a plant's parent company f, MEP_t is an indicator variable taking on the value of one for the years following the MEP, F_p is an indicator variable taking on the value of one if plant p was (a) subject to an administrative enforcement action in the five years prior to 2011 or whether (b) the plant is located in a county, previously designated to be in non-attainment status, $ln(emp)_{p,t}$ is the natural logarithm of plant p's total employment in year t, $\alpha_{f,c,t}$ is a parent-chemical-time fixed effect, $\alpha_{c,p}$ is a chemical-plant fixed effect, $\alpha_{g,c,t}$ is a group-chemical-year fixed effects and $\alpha_{i,t}/\alpha_{l,t}/\alpha_{i,c,t}/\alpha_{i,c,l,t}$ are industry-year/county-year/industry-chemical-year/industry-county-chemical-year fixed effects. The addition of parent-chemical-year fixed effects implies that the coefficient β identifies the differential effect of a parent's greater long-term debt dependence on the likelihood of implementing pollution abatement activities *within* firms and across plants, depending on whether (a) the plant was subject to an enforcement action or whether (b) the plant is located in a county at higher risk of being designated to be in non-attainment status.

Results from estimating regression model (7) are reported in Table 9. Consistent with the earlier results I find that the coefficient on the triple-interaction is positive and statistically significant. Moreover, due to the parent-chemical-year fixed effect, unobservable time-varying effects at the parent-level, such as differences in firm's management and environmental stance, are accounted for. Furthermore, the coefficient in Table 9 shows the differential effect *within* a parent company. Reducing pollution is costly and the results in Table 9 are consistent with the idea that the MEP allows firms to increase their emission reduction activities on certain plants. Specifically, firms center the activities in plants that are at higher risk of facing additional costs due to pollution. Thus, this finding is consistent with the idea that a relaxation of financial constraints due to the MEP allows firms to implement pollution abatement investments in facilities at higher risk of facing additional costs.

6 Conclusion

In this paper, I examine how the Maturity Extension Program (MEP) affects a firm's corporate social responsibility, particularly its focus on the environment. Since the MEP decreases the supply of long-term U.S. Treasury securities, it leads to a reduction in financing costs for firms that are more dependent on long-term debt (Greenwood et al., 2010; Vayanos and Vila, 2009). Foley-Fisher et al. (2016) find that firms that are more dependent on long-term debt exhibit a boost in their market valuation as well as an increase in the issuance of debt and investments.

Using information on corporate environmental responsibility, I find that firms that rely more on long-term debt and hence are more exposed to the MEP increase their focus on the environment following the MEP. This effect is robust to the inclusion of additional fixed effects and not sensitive to the definition of long-term debt dependence. Furthermore, I find that firms with a greater long-term debt dependence are more likely to reduce toxic emissions and improve their use of input resources.

To examine this further, I examine facility-level data and analyze whether plants belonging to parent companies that are more exposed to the MEP reduce pollution more. The advantage of this micro-level data is that they allow me to account for unobservable influences at the geography and industry level by including a set of fixed effects in the analysis. I find that plants, belonging to parents with a greater long-term debt dependence reduce toxic emissions more following the MEP. This finding is (1) robust to the inclusion of additional fixed effects, (2) not driven by specific chemicals, and (3) not affected by potential biases due to plants' self-reporting of emissions.

The micro-data also report whether plants invest in pollution abatement procedures and implement activities to reduce toxic emissions. Following the earlier empirical specification, I find that facilities belonging to parent companies with a greater long-term debt dependence are more likely to engage in activities to reduce toxic emissions. Exploiting heterogeneity across plants, I find that the likelihood of implementing emission reduction activities is higher for plants that are at higher risk of facing additional costs due to the violation of environmental regulations. Specifically, I find that plants that (a) faced a prior enforcement action and plants that are (b) located in counties that are at higher risk of prompting regulatory intervention as the pollution in an area deteriorates, are more likely to implement measures to reduce pollution. Finally, I exploit variation within a parent company and year and analyze differences in the likelihood of implementing pollution reduction measures across plants within the same firm. I find that firms that were more affected by the MEP due to their debt structure concentrate their pollution reduction activities in plants that were at higher risk of facing additional costs in order to comply with environmental regulations.

The results are consistent with the idea that the MEP reduced financial constraints for firms with a greater long-term debt dependence. This allowed firms to increase their focus on the environment by reducing toxic emissions and implementing pollution abatement procedures.

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Tables

Table 1: Summary statistics

This table reports descriptive statistics of variables, used in the analysis. 'Environmental/Governacne/Social Score' is Thomson Reuter's relative ranking reagrding the firms performance and effort towards the environment, society and firm governance; 'ESG Score' is Thomson Reuters's combined ESG Score; 'Emission Reduction/Ressource Use/Innovation Score' is the relative ranking of the firm's focus on reducing emissions/using ressources more efficiently/investing in green innovations; 'Long-term debt dependence' is the average of total debt with a maturity of more than one year, scaled by total debt using information up until 2007; 'Long-term debt dependence 3-year cut-off' is the average of total debt with a maturity of more than three years, scaled by total debt using informtion up until 2007; 'Long-term debt dependence until 2010' is the average of total debt with a maturity of more than one year, scaled by total debt using information up until 2011; 'Book-to-market ratio' is the ratio of book equity over market capitalization; 'Average Q' is the market capitalization + total assets - book equit, sclaed by lagged total assets; 'Investment opportunity' is capital expenditure, scaled by a firm's sales; 'Short-term financial constraint' is the difference between receivables and payables, divided by sales. 'Total onsite release' is the reported total on-site emission of a chemical at a plant; 'Emission Reduction Activities dummy' is a dummy variable, taking on the value of one whether a plant reports activities to reduce toxic emissions for a chemical; 'Total Employment' is the plant's total employment

	N	Mean	St.Dev.	Min	Max
Parent Company					
Environmental Score	9,565	52.59	22.70	10.46	95.49
Governance Score	9,400	55.62	19.89	14.81	94.99
Social Score	9,387	55.82	20.70	9.26	94.35
ESG Score	9,430	54.65	17.46	19.65	89.69
Emission Reduction Score	9,425	52.52	28.45	1.5	99.24
Ressource Use Score	9,392	53.35	28.62	5.95	99.21
Innovation Score	9,393	52.01	24.51	1.95	98.82
Long-term debt dependence	9,565	0.87	0.19	0	1
Long-term debt dependence 3 year cut-off	8,883	0.54	0.26	0	1
Long-term debt dependence until 2010	9,454	0.9	0.16	0	1
Book-to-market ratio	9,565	0.50	0.50	-7.96	5.00
Debt / Assets	9,565	0.27	0.21	0	2.06
Long-term-debt / Assets	9,565	0.25	0.21	0	2.03
Return on assets	9,565	0.02	0.07	-1.10	0.23
Income / assets	9,565	0.15	0.11	-0.95	0.68
Average Q	9,565	2.13	1.67	0.32	36.76
Investment opportunity	9,565	0.12	0.25	0	5.06
Short-term financial constraint	9,565	0.06	0.14	-6.80	2.72
Capital intensity	9,565	0.05	0.03	0	0.33
Plant-Chemical Level					
Total onsite release (thousand pounds)	206,731	30.28	266.07	0	22,292.52
Emission Reduction Activities Dummy (*100)	206,731	3.03	17.15	0	100.00
Total Employment	122,053	261.14	577.75	1	15,000.00

Table 2: Maturity Extension Program, long-term debt dependence and corporate environmental responsibility

This table reports results from an OLS regression at the firms level. The dependent variable is Thomson Reuters's Environmental Score. The sample period ranges from 2006 to 2016 and covers all firms in the Compustat universe with an ESG Score over the sample period.'MEP' is a dummy variable taking on the value of one in the year after the MEP, i.e. 2011. All other variables are defined in Table 1. Standard errors are clustered at the firm level, and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	(1)	(2)	(3)	(4)	(5)
Long-term debt dependence * MEP	1.162**	1.315**	1.598***		
	(0.558)	(0.561)	(0.582)		
Long-term (3Y) debt dependence * MEP				0.968*	
				(0.565)	
Long-term (2011) debt dependence * MEP					2.118***
					(0.739)
Book-to-market ratio		-0.704	-0.727	-0.841	-0.723
		(0.514)	(0.568)	(0.578)	(0.565)
Debt / Assets		2.039	1.292	2.307	1.583
		(4.950)	(5.266)	(5.586)	(5.283)
Long-term ebt / Assets		-2.058	-0.972	-2.203	-1.045
		(5.375)	(5.593)	(5.928)	(5.611)
Return on assets		2.721	1.591	2.507	1.576
		(2.729)	(2.903)	(3.052)	(2.904)
Income / assets		1.887	0.380	-0.943	0.371
		(3.174)	(3.336)	(3.485)	(3.333)
Average Q		-0.713***	-0.605***	-0.617***	-0.608***
		(0.193)	(0.207)	(0.228)	(0.209)
Investment opportunity		-1.084	-1.952	-2.607*	-1.931
		(1.152)	(1.226)	(1.335)	(1.233)
Short-term financial constraint		0.596	0.136	-0.455	0.103
		(2.467)	(2.312)	(2.049)	(2.305)
Capital intensity		-1.574	-9.319	-4.340	-9.647
		(14.758)	(15.642)	(17.055)	(15.644)
Firm fixed effects	x	x	x	x	x
Year fixed effects	x	x			
Industry-year fixed effects			x	x	x
Observations	9,565	9,565	9,498	8,827	9,494
R-squared	0.842	0.844	0.856	0.856	0.856

Table 3: Maturity Extension Program, long-term debt dependence and corporate social responsibility - Subscores

This table reports results from an OLS regression at the firm level. The dependent variables are different ESG Scores, reported by Thomson Reuters. The dependent variable in Panel A is the combined ESG Score; the dependent variables in Panel B are subscores for the 'Social' and 'Governance' dimension; the dependent variables in Panel C are ESG subscores capturing a firm's focus on the environment. The sample period ranges from 2006 to 2016 and covers all firms in the Compustat universe with an ESG Score over the sample period.'MEP' is a dummy variable taking on the value of one in the year after the MEP, i.e. 2011. All other variables are defined in Table 1. Standard errors are clustered at the industry level, and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A:	Panel B:		Panel C:		
	ESG Score	Social	Governance	Emissions	Ressource Use	Innovation
Long-term debt dependence * MEP	0.872**	0.303	0.616	2.636***	1.847**	0.139
	(0.414)	(0.499)	(0.693)	(0.783)	(0.800)	(0.814)
Firm controls	x	x	x	x	x	x
Firm fixed effects	x	x	x	x	x	x
Industry-year fixed effects	x	x	x	x	x	x
Observations	9,346	9,323	9,310	9,350	9,318	9,324
R-squared	0.876	0.840	0.717	0.823	0.837	0.725

Table 4: Maturity Extension Program, long-term debt dependence and toxic emissions

This table reports results from an OLS regression at the plant-chemical-level. The dependent variable is the natural logarithm of total on-site emissions for a chemical at the facility. The sample period ranges from 2006 to 2016 and covers all plants that can be matched to parent companies, reported in Compustat. 'MEP' is a dummy variable taking on the value of one in the year after the MEP, i.e. 2011. All other variables are defined in Table 1. Coefficients are standardized. All regressions include fixed effects as indicated. Standard errors are clustered at the chemical-year level, and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Long-term debt dependence * MEP	-0.737***	-0.963***	-0.743***	-1.064***	-1.056***	-1.592***
	(0.164)	(0.233)	(0.239)	(0.308)	(0.319)	(0.485)
Plant controls		0.348	0.343	0.428	0.264	0.941*
ln(Total Employment)		(0.221)	(0.229)	(0.302)	(0.305)	(0.526)
Parent control variables		x	x	x	x	x
Year fixed effect	x	x				
Plant-chemical fixed effect	x	x	x	x	x	x
Chemical-year fixed effect			x	x	x	
County-year fixed effect				x	x	
Industry-year fixed effect				x		
Industry-chemical-year fixed effect					x	
Industry-chemical-county-year fixed effect						x
Observations	200,272	109,560	108,715	107,346	105,468	32,282
R-squared	0.938	0.936	0.939	0.948	0.951	0.960

Table 5: Maturity Extension Program, long-term debt dependence and toxic emissions - Robustness

This table reports results from an OLS regression at the plant-chemical-level. The dependent variable is the natural logarithm of total on-site emissions. The sample period ranges from 2006 to 2016 and covers all plants that can be matched to parent companies, present in Compustat. The sample in Panel A/Panel B focuses on the 40/20 most common chemicals, reported in the Toxic Release Inventory. 'MEP' is a dummy variable taking on the value of one in the year after the MEP, i.e. 2011. All other variables are defined in Table 1. Coefficients are standardized. All regressions include fixed effects as indicated. Standard errors are clustered at the chemical-year level, and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: 40 most common chemicals				Panel A: 20 most common chemicals			
Long term debt dependence * MEP	-0.547**	-0.788**	-0.837**	-1.353***	-0.522*	-0.955***	-0.887**	-1.146**
	(0.255)	(0.330)	(0.338)	(0.488)	(0.270)	(0.355)	(0.358)	(0.511)
Control variables	x	x	x	x	x	x	x	x
Plant-chemical fixed effect	x	x	x	x	x	x	x	x
Chemical-year fixed effect	x	x	x		x	x	x	
County-year fixed effect		x	x			x	x	
Industry-year fixed effect		x				x		
Industry-chemical-year fixed effect			x				x	
Industry-chemical-county-year fixed effect				x				x
Observations	85,564	84,050	83,683	29,716	66,542	64,879	64,703	25,361
R-squared	0.944	0.954	0.955	0.962	0.945	0.956	0.957	0.961

Table 6: Maturity Extension Program, long-term debt dependence and hazardous pollutants

This table reports results from an OLS regression at the monitor-pollutant level.The dependent variable is the natural logarithm of hazardous pollutants, recorded at monitoring stations, over the period 2006 - 2016. The main independent variable is the distance weighted average 'Long-term debt dependence' of all plants within a 20 mile radius of the monitoring station. The dependent variable in Panel A is the natural logarithm of the arithmetic average of hazardous pollutants in a year, the dependent variable in Panel B is natural logarithm of the median level of hazardous pollutants over a year, and the dependent variable in Panel C is the natural logarithm of the 90th percentile of hazardous pollutants within a year. 'MEP' is an indicator variable taking on the value of one in the years after 2011, and zero otherwise.Coefficients are standardized. All regressions include fixed effects as indicated. Standard errors are clustered at the monitor-pollutant level, and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Average		Median		90th percentile	
Long-term debt dependence * MEP	-0.351***	-0.623***	-0.302***	-0.508***	-0.340***	-0.340***
	(0.067)	(0.087)	(0.078)	(0.107)	(0.065)	(0.065)
Monitor-pollutant fixed effect	x	x	x	x	x	x
Pollutant-year fixed effect	x		x		x	
County-pollutant-year fixed effect		x		x		x
Observations	98,501	94,428	98,418	94,339	98,469	98,469
R-squared	0.997	0.997	0.995	0.996	0.997	0.997

Table 7: Maturity Extension Program, Long-term debt dependence and source reduction activities

This table reports results from an OLS regression at the plant-chemical-level. The dependent variable is a dummy variable taking on the value of one whether the plant reports activities to reduce emissions for that chemical. The sample period ranges from 2006 to 2016 and covers covers all plants that can be matched to parent companies, present in Compustat. The sample in Panel A uses the full sample while the sample in Panel B uses information from the 20 most common chemicals. 'MEP' is a dummy variable taking on the value of one in the year after the MEP, i.e. 2011. All other variables are defined in Table 1. Coefficients are standardized. All regressions include fixed effects as indicated. Standard errors are clustered at the chemical-year level, and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: Full sample				Panel B: 20 most common chemicals			
Long-term debt dependence * MEP	0.146	0.405*	0.438**	1.212***	0.374**	0.608**	0.566**	1.167***
	(0.143)	(0.215)	(0.222)	(0.339)	(0.167)	(0.264)	(0.265)	(0.378)
Control variables	x	x	x	x	x	x	x	x
Plant-chemical fixed effect	x	x	x	x	x	x	x	x
Chemical-year fixed effect	x	x	x		x	x	x	
County-year fixed effect		x	x			x	x	
Industry-year fixed effect		x				x		
Industry-chemical-year fixed effect			x				x	
Industry-chemical-county-year fixed effect				x				x
Observations	109,416	108,048	106,184	32,466	67,052	65,416	65,250	25,507
R-squared	0.330	0.435	0.450	0.584	0.312	0.435	0.444	0.575

Table 8: Maturity Extension Program, long-term debt dependence and source reduction activities - Differential effects

This table reports results from an OLS regression at the plant-chemical-level. The dependent variable is a dummy variable taking on the value of one whether the plant reports activities to reduce emissions for that chemical. The sample period ranges from 2006 to 2016 and covers covers all plants that can be matched to parent companies, present in Compustat. 'MEP' is a dummy variable taking on the value of one in the year after the MEP, i.e. 2011. All other variables are defined in Table 1. A firm's long-term debt dependence is interacted with a dummy variable, indicating whether that plant belongs to a group that is considered to be exposed to a greater risk of experience additional costs due to environmental reasons. The dummy variable in Panel A takes on the value of one whether a plant was subject to an enforcement action in the five years prior to the MEP; the dummy variable in Panel B takes on the value of one whether a plant is located in a county that ever was in non-attainment status prior to the MEP. 'Average Effect' is the average effect of 'long term debt dependence' for plant, belonging to the respective group. Coefficients are standardized. All regressions include fixed effects as indicated. Standard errors are clustered at the chemical-year level, and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	(1)	(1)	(2)	(3)	(4)	(5)	(6)	(6)
	Panel A: Plants, subject to a prior enforcement action				Panel B: Plants, located in previous non-attainment counties			
Long term debt dependence * MEP	0.055	0.176	0.226	0.540	0.188	0.121	0.177	0.803
	(0.167)	(0.243)	(0.252)	(0.382)	(0.185)	(0.344)	(0.356)	(0.721)
Long term debt dependence * MEP * Group	0.513**	1.140***	1.073***	2.434***	0.056	0.575	0.550	0.435
	(0.253)	(0.357)	(0.371)	(0.588)	(0.219)	(0.352)	(0.363)	(0.708)
Average Effect	0.568**	1.317***	1.299***	2.974**	0.244	0.697***	0.726***	1.238***
	(0.225)	(0.335)	(0.345)	(0.552)	(0.177)	(0.226)	(0.233)	(0.305)
Control variables	x	x	x	x	x	x	x	x
Plant-chemical fixed effect	x	x	x	x	x	x	x	x
Group-chemical-year fixed effect	x	x	x	x	x	x	x	x
County-year fixed effect		x	x			x	x	
Industry-year fixed effect		x				x		
Industry-chemical-year fixed effect			x				x	
Industry-chemical-county-year fixed effect				x				x
Observations	108,556	107,176	105,363	32,035	82,922	80,887	80,394	19,212
R-squared	0.339	0.444	0.458	0.594	0.502	0.615	0.622	0.746

Table 9: Maturity Extension Program, Long term debt dependence and source reduction activities - within parents

This table reports results from an OLS regression at the plant-chemical-level. The dependent variable is a dummy variable taking on the value of one whether the plant reports activities to reduce emissions for that chemical. The sample period ranges from 2006 to 2016 and covers covers all plants that can be matched to parent companies, present in Compustat. 'MEP' is a dummy variable taking on the value of one in the year after the MEP, i.e. 2011. All other variables are defined in Table 1. A firm's long-term debt dependence is interacted with a dummy variable, indicating whether that plant belongs to a group that is considered to be exposed to a greater risk of experience additional costs due to environmental reasons. The dummy variable in Panel A takes on the value of one whether a plant was subject to an enforcement action in the five years prior to the MEP; the dummy variable in Panel B takes on the value of one whether a plant is located in a county that ever was in non-attainment status prior to the MEP. Coefficients are standardized. All regressions include fixed effects as indicated. Standard errors are clustered at the chemical-year level, and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	(1)	(1)	(2)	(3)	(4)	(5)	(6)	(6)
	Panel A:				Panel B:			
	Plants, subject to a prior enforcement action				Plants, located in previous non-attainment counties			
Long term debt dependence * MEP * Group	0.673*	1.218*	1.241*	3.086**	0.346	1.270**	1.386**	0.798
	(0.408)	(0.647)	(0.668)	(1.435)	(0.330)	(0.562)	(0.562)	(1.215)
Control variables	x	x	x	x	x	x	x	x
Plant-chemical fixed effect	x	x	x	x	x	x	x	x
Group-chemical-year fixed effect	x	x	x	x	x	x	x	x
Parent-chemical-year fixed effect	x	x	x	x	x	x	x	x
Chemical-year fixed effect	x	x	x		x	x	x	
County-year fixed effect		x	x			x	x	
Industry-year fixed effect		x				x		
Industry-chemical-year fixed effect			x				x	
Industry-chemical-county-year fixed effect				x				x
Observations	82,922	80,887	80,394	19,212	82,743	80,712	80,208	19,268
R-squared	0.502	0.615	0.622	0.746	0.502	0.616	0.624	0.744

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