Tax-Subsidized Green Bonds and their Real Effects*

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Abstract

This paper studies the use and the corporate real effects of green bonds that are tax-subsidized, thus offering a source of low-cost financing for green projects. Using a large, novel sample of pollution control bonds that finance pollution abatement facilities of U.S. public firms, I document that tax-subsidized green bonds are disproportionately used by large firms, even within industries. Issuance of tax-subsidized green bonds increases when the yields of conventional bonds are high. Analyzing the high-interest rate period of the early 1980s, I find that firms using such bonds display an increase in output after issuance. From an issuer perspective, this output effect highlights a potential positive economic aspect associated with conducting tax-subsidized green investments when conventional financing costs are high.

JEL classification: G32, G38, H23, H32

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"... A spokesman for IBM said the company was using tax-exempt pollution control bonds for the first time because of the 'sustained high cost of borrowing'. 'With rates what they are, this method of financing was found to be more attractive than in the past,' the spokesman said."
— Kreps (1981), in: The Bond Buyer.

1. Introduction

With the recent growth of the corporate green bond market, considerable attention has been paid to whether these bonds are issued at a (negative) premium compared to conventional corporate bonds. Based on the relatively short history of this financing instrument,[1] the empirical literature examining corporate green bonds finds that the premium at issue is at best economically small. For example, Flammer (2021) finds no evidence of a premium at issue, and Caramichael and Rapp (2024) show that the negative premium ranges from three to eight basis points.[2] These findings are particularly interesting from a corporate financing perspective, as they indicate that green bonds so far do not substantially reduce the financing costs of green projects. This, in turn, suggests that cost of capital considerations do not appear to be the main driver for the issuance of corporate green bonds (Flammer, 2021).

Despite the growth of the (corporate) green bond market, the current market development is unlikely to meet the capital needs to address the enormous environmental challenges of today (Migliorelli and Dessertine, 2019). Therefore, subsidies are generally discussed as a fiscal policy tool to increase the growth of the green bond market (Chiang, 2017; Climate Bonds Initiative, 2024b). One possible approach is the use of tax incentives that reduce financing costs for corporate green bond issuers (Climate Bonds Initiative, 2024c).

If corporate green bonds are tax-subsidized and thus a source of low-cost financing for green projects, what type of companies are utilizing such a fiscal policy tool? What conditions in the conventional bond market spur their use? What are the real effects associated with the

[1] The first labeled corporate green bond was issued in November 2013 (see, e.g., Climate Bonds Initiative, 2024a).

[2] Similarly, studying green municipal bonds, Larcker and Watts (2020) find no evidence for a premium at the issue in the municipal bond market, and Baker et al. (2022) document that the premium is economically small. Zerbib (2019), analyzing a sample of governmental and corporate green bonds, finds a small negative premium of about two basis points.

use of low-cost, tax-subsidized green bonds? I introduce a novel, large sample of tax-exempt pollution control bonds (PCBs) to explore these questions. This sample covers 3,200 PCBs issued between 1980 and 2013 to finance pollution abatement facilities of U.S. public firms.

Three key characteristics make pollution control bonds particularly well suited to study tax-subsidized green bonds: (i) Pollution control bonds have significantly lower financing costs than conventional corporate bonds (see, e.g., California Pollution Control Financing Authority, 2024b). This is because they are issued as conduit bonds on the tax-exempt municipal bond market, which had consistently lower average yields compared to taxable corporate bond yields throughout the sample period. In the early 1980s, the yield spread between high-rated taxable corporate bonds and municipal bonds was particularly large. For example, in 1981, Merrill Lynch estimated that utilities could issue Aa-rated PCBs at a yield of about 11.5%, while conventional financing rates would have been about 1.5 times that level (The Bond Buyer, 1981).[3] (ii) Because the proceeds from PCBs are invested in the construction, acquisition, or installation of pollution abatement facilities (see, e.g., California Pollution Control Financing Authority, 2024b; Golemon and Burgin, 1983; McBride and Dreifus, 1983), the underlying financing purpose would typically allow these bonds to be labeled as green under current standards (California Pollution Control Financing Authority, 2024a).[4] (iii) While measurement challenges often complicate the analysis of local corporate incentive programs (Slattery and Zidar, 2020), the pollution control bond dataset allows for a comprehensive analysis of tax-subsidized green bonds from a corporate perspective. In particular, bond-level data provide insight on the corporate use of the tax subsidy and can be linked to firm financial data.[5]

I start by descriptively introducing the sample of firms that use pollution control bonds and thus a source of low-cost financing for pollution control projects.[6] I adapt the approach

[3]For a comprehensive overview of the average yield for high-rated taxable corporate bonds and high-rated municipal bonds between 1980 adnd 2013, see Council of Economic Advisers (2023), Table B–42.

[4]In this regard, the International Capital Market Association (2021) lists pollution prevention and control as one of the eligible categories for green projects. To date, however, PCBs are often not labeled as green bonds (Baker et al., 2022).

[5]Another feature of PCBs is that, from a corporate perspective, PCBs are largely comparable to conventional debt financing setups, despite the municipal conduit in between (Kutak and Wagner, 1974-1975).

[6]I use the term "issuer" to refer to the firm that uses the bond proceeds and solely secures the PCB issue, even though the ultimate issuer is a municipal conduit.

of Chodorow-Reich et al. (2022) to explore the use of PCBs across the firm-size distribution and show that pollution control bonds are used disproportionately by large firms, even within industries. Further, I show that PCBs are primarily used by firms in the manufacturing and utility industries, which together account for about 97% of the issuance volume in the sample. Looking at public firms' PCB issuance over time, the use of PCBs peaked in the first half of the 1980s, with a total issuance volume of about USD 20b between 1980 and 1984.

Then, I turn to the market conditions that might spur the use of PCBs. In particular, I ask whether PCB issuance is correlated with financing costs on the conventional corporate bond market. Anecdotal examples suggest that tax-subsidized PCBs may be considered as a financing source for abatement investments especially during periods of high conventional financing costs (see, e.g., Kreps, 1981, reporting in The Bond Buyer on a PCB issuance by IBM in 1981). Using both quarterly aggregate and firm-level PCB issuance data, I find that PCB issuance is positively associated with Moody's yield for Aaa- and Baa-rated corporate bonds. For the firm-level sample of PCB issuers, a one percentage point increase in the conventional Aaa-rated bond yield is associated with a 4.1% increase in the probability of issuing a new money PCB—thus a bond of which the proceeds are used for a new pollution abatement project.[7] Additionally, I show that the issuance of refunding PCBs is negatively correlated with conventional bond market yields.

Motivated by the documented positive correlation between the issuance of new money PCBs and conventional bond yields, I finally analyze whether the issuance of tax-subsidized green bonds during the period of high interest rates between 1980 and 1984 is associated with post-issuance real effects for these firms. I focus on sales, capital expenditures, and R&D expenditures as economic aspects that could be linked to the undertaking of tax-subsidized green investments at relatively low cost.[8] In the absence of (quasi-)random assignment of firms as

[7]The municipal bond market distinguishes between new money bonds, which finance new projects, and refunding bonds, respectively (see, e.g., United States Government Accountability Office, 2008).

[8]Previous literature has analyzed the relation between environmental regulation and firm's competitiveness. For example, Greenstone, List and Syverson (2012) find that stricter air quality regulations have a negative effect on manufacturing firm's competitiveness and output, thus are associated with economic costs. Porter and van der Linde (1995), on the other hand, argue that environmental regulation can have a positive effect on competitiveness through an innovation channel. With respect to corporate social responsibility (CSR), Di

PCB issuers, I apply the approach of Flammer (2021) and compare PCB issuers that tap the PCB market between 1980 and 1984 with a matched control group that never uses PCBs until 2013. I thereby require the control firms to operate in the same industry and be headquartered in the same state as the respective PCB issuer. Then, I select the nearest neighbor for each issuer, using size, return on assets, the capex-to-assets ratio, the property, plant, and equipment-to-assets ratio, and sales growth as matching variables. The sample comprises 149 PCB issuers and 149 matched control firms.

Using the matched sample in a difference-in-differences regression framework, I find that PCB issuance is positively associated with post-issue sales growth: PCB issuers that tap the PCB market during the high interest rate period 1980 to 1984 display a relative increase in sales growth by 2.4% to 3.0% over the three-year window after the issuance. This finding is robust to the use of an alternative control group that additionally requires PCB issuers and control firms to be in the same size quintile. Overall, while this result does not imply a causal relation, it suggests that the use of a low-cost source of financing for pollution abatement investments is correlated with potential positive economic aspects for the issuers.

Finally, I use the matched sample to examine whether the issuance of pollution control bonds is associated with a change in capital investment or R&D investment. While I find no statistically significant association of PCB issuance with capital investment, I do find that PCB issuance is positively associated with R&D investment after the bond issuance.

This paper relates to several strands of the literature. First, it contributes to the growing literature that examines green bonds as financial instruments.[9] Within this strand, both municipal green bonds (e.g., Baker et al., 2022; Karpf and Mandel, 2018; Larcker and Watts, 2020, among others) and corporate green bonds (e.g., Caramichael and Rapp, 2024; Dang, Wang and Wang, 2022; Flammer, 2021; Tang and Zhang, 2020, among others) are examined from different points of view. Flammer (2021) and Daubanes, Mitali and Rochet (2021) analyze motives for

Giuli and Kostovetsky (2014) document that an increase in CSR is negatively related to future revenue growth. CSR is a voluntary initiative and may be perceived as costly from the firm's perspective. PCBs, however, are essentially a subsidy for a firm's pollution abatement investment.

[9]Cortellini and Panetta (2021) provide a broad overview of the green bond literature.

the issuance of corporate green bonds. As (non-subsidized) corporate green bonds are a relatively new financial instrument, I add to this literature by introducing and examining the use of a comparably large U.S. sample of tax-subsidized "corporate" green bonds, covering more than 30 years of issuance: corporate-backed pollution control bonds issued through municipal conduits to finance pollution abatement facilities of U.S. public firms.[10]

Second, I relate to the literature that studies the real effects of green financial instruments. Flammer (2021) shows that corporate green bond issuers subsequently improve their environmental performance. For banks that use green bonds, Fatica, Panzica and Rancan (2021) document a reduction in lending to carbon-intensive sectors. Flammer (2021) and Tang and Zhang (2020) document ownership changes after green bond issuance. My focus is on sales growth and corporate investment as economic aspects that could be linked to firms' use of green bonds. In particular, I show that the issuance of tax-subsidized pollution control bonds is positively associated with sales growth and R&D investment.[11]

Third, I broadly relate to the literature on financing conditions and green investments as well as environmental outcomes. Among others, Bartram, Hou and Kim (2022) and Xu and Kim (2022) show that financial constraints lead to an increase in firm emissions. De Haas et al. (2024) document, among other findings, that credit constraints reduce investment in green technologies, while these constraints play a minor role with respect to investment in pollution control. Hartzmark and Shue (2023) show that increasing financing costs for brown firms makes them (much) more brown, while reducing the financing costs for green firms only leads to minor additional environmental improvements. Accetturo et al. (2024) show that the supply of credit increases the likelihood that firms undertake green investments, with the effect being amplified when government subsidies are available. I document that the use of tax-subsidized pollution control bonds increases with conventional bond market yields.

Finally, my work relates to the stream of literature that examines fiscal policies directed

[10]Previous literature has studied pollution control bonds issued by utility firms: Khanchel, Lassoued and Bargaoui (2024) study PCBs of energy utility firms and environmental performance measures. Varma and Szewczyk (1990) study the sale of PCBs by public utilities and share price reactions.

[11]Wang, Liu and Wang (2022) specifically examine green innovation in the context of green bond issuance in China and document a positive correlation with bond issuance.

at the private sector and aimed at improving environmental outcomes. In a survey on climate finance conducted by Stroebel and Wurgler (2021), the surveyed researchers and practitioners rank research on such government incentives as the most important research topic among a list of thirteen topics provided. There is also considerable political interest in the impact of such fiscal measures (see, e.g. Delgado-Téllez, Ferdinandusse and Nerlich, 2022; Eurostat, 2015, for the European Union). Much work has been devoted to the study of carbon taxes. Timilsina (2022) provides a comprehensive overview. Williams III (2016) examines environmental taxes more broadly. On the other hand, various types of corporate subsidies are also commonly employed fiscal instruments to incentivize sustainable investment (Columbia Center on Sustainable Investment, 2022; Lovei, 1995). I provide comprehensive insights on the use and real effects of PCBs as a long-standing subsidy tool.

The remainder of the paper is structured as follows. Section 2 describes the data. Section 3 presents stylized facts for the use of pollution control bonds. Section 4 presents results for the correlation between conventional bond yields and PCB issuance, and Section 5 presents results for the real effects associated with PCB issuance. Section 6 concludes.

2. Data and descriptive statistics

2.1. Data sources

I make use of two main data sources to construct a sample of U.S. public firms that issue pollution control bonds. First, I obtain data on pollution control bonds from the Municipal New Issues Database in SDC Platinum. Second, I obtain firm financial data from Compustat.

Within SDC Platinum, PCBs are identified based on the bond's main use of proceeds classified as "pollution control". I exclude bonds that are marked as general obligation bonds since pollution control bonds should be in the structure of revenue bonds (see, e.g., Friedman, 1976). I also exclude taxable bonds because it is not obvious that they reduce financing costs relative to conventional financing sources. In addition, I remove bonds that are neither classified as new money nor as refunding bonds. I hand-match the names of the corporate backers of these

bonds—the firms that use the bond proceeds and secure the issue—to Compustat based on (historic) company names. For one part of my analyses, I aggregate the bond-level data at the calendar year-quarter level.

The sample period starts in 1980, as this is the first year for which SDC Platinum comprehensively covers pollution control bonds. Refunding bonds are included from 1983 onwards, in line with their comprehensive data availability in SDC Platinum.[12] I choose 2013 as the final year of the tax-subsidized green bond sample because the first labeled corporate green bond was issued in November 2013 (see, e.g., Climate Bonds Initiative, 2024a).

For the firm-level analyses, I aggregate PCB issuance data at the firm-year level. I drop firm years with missing information on lagged total assets, lagged return on assets, and lagged leverage. I also exclude financial firms (SIC codes 6000–6999) because new money bonds are only allocated to this industry in four firm years. All continuous financial variables are winsorized at the 1^{st} and 99^{th} percentiles.

For the group of non-PCB issuing firms in Compustat, I additionally make the following adjustments: I broadly follow Flammer (2021) and exclude non-PCB issuers that never report any debt during the sample period, as PCBs are a source of external financing. Further, I exclude firms that report total assets of zero at any point in time during the sample period. Following Almeida and Campello (2007), I exclude firms with a market-to-book ratio greater than 10. Finally, I drop non-PCB issuers in industries, measured at the two-digit SIC level, without any pollution control bond issuance.

For the conventional bond market yield, I use Moody's yield for Aaa-rated corporate bonds, which I obtain from the Federal Reserve Bank of St. Louis economic data repository. Finally, I also obtain information on U.S. GDP per cap as well as recession indicators from the Federal Reserve Bank of St. Louis economic data repository.

[12] A few refunding bonds are reported in SDC Platinum for 1982, but these bonds are not included in the sample.

2.2. Descriptive statistics

Summary statistics are displayed in Table 1. The initial bond-level sample contains 3,200 PCBs issued between 1980 and 2013. The total issuance volume over this period is about USD 136b in nominal terms, and USD 220b when adjusted for inflation and expressed in 2013 USD.[13] Of these bonds, 1,693 are new money bonds that fund new pollution control facilities.

The firm-level sample captures 313 unique PCB issuers and 846 firm years with a new money PCB issuance. Overall, the dataset on PCBs can be considered large compared to datasets used in previous analyses of the non-subsidized U.S. corporate green bond market (see, e.g., Baker et al. (2022), as well as the information on the U.S. within the international sample used by Flammer (2021)), but the latter span a shorter time period compared to my PCB sample.

3. Corporate utilization of pollution control bonds

Following Flammer (2021), I first present several stylized facts on the use of tax-subsidized PCBs in my sample, highlighting similarities and differences with the use of non-subsidized corporate green bonds as described in the literature.

Flammer (2021) finds that firms' primary rationale for issuing (non-subsidized) green bonds is to signal their environmental commitment to investors. In contrast, for the sample of pollution control bonds issued between 1980 and 2013, the tax subsidy's effect that lowers the cost of capital for these green investment projects is likely a more central consideration in firms' decision-making. In that regard, Lovei (1995) argues that firms generally weigh the costs and benefits of pollution abatement investments, thereby also taking into account subsidies (see Lovei, 1995, for a detailed introduction on such investment decisions).[14]

[13] I use the Consumer Price Index provided by the U.S. Bureau of Labor Statistics to adjust the issuance volume for inflation whenever I consider the full sample period between 1980 and 2013.

[14] The investment in pollution control has often been described as non-productive (see, e.g., Chell, 1982; Ray, 1975).

3.1. Utilization by year

Figure 1 shows the development of pollution control bond issuance over time. For new money bonds, 1984 is the year with the highest issuance in terms of both the number of bonds (198) and the total volume of bonds ($7.6b). As noted by Ryan (1985), the 1984 issuance volume also marks an "all-time high" relative to all previous years, and thus relative to the years before the sample period.[15] Overall, the early sample years between 1980 and 1985 may be described as the boom period for pollution control bond issuance.[16] Some early sample years also show high growth rates in issuance: PCB issuance increased by about 78% between 1980 and 1981, and by about 168% between 1983 and 1984. The development of PCB issuance in the first half of the 1980s is thus roughly comparable to the strong growth in (non-subsidized) green bond issuance between 2013 and 2018, as illustrated by Flammer (2021).

Since 1986, the issuance of new money PCBs has been at a much lower level than in the first half of the 1980s. This is due to regulatory reasons, as the 1986 Tax Reform Act generally restricted the issuance of municipal conduit bonds for private sector entities (see, e.g., Zimmerman, 1990, for details on the impact of the tax reform). The restrictions imposed by the 1986 Tax Reform do not affect the issuance of refunding bonds (IRC Section 146), so that 1993 represents the year with the highest refunding activity during the sample period (129 bonds, with a total issuance volume of $5.2 billion).

3.2. Utilization by industry

Figure 2 shows total pollution control bond issuance by industry division, whereby industry divisions are determined using two-digit SIC codes. PCB issuers come primarily from two industry divisions: firms in the transportation and public utilities industry (two-digit SIC 40-49) are the major users (53% of bonds and 75% of bond volume), followed by firms in the

[15] In 1984, PCB issuance by all types of private sector firms also accounted for about 10% of the total issuance volume in the long-term municipal bond market (Ryan, 1985).

[16] In Appendix Figure B.1, I additionally show the development of PCB issuance volumes adjusted for inflation. This further highlights the relative issuance boom in the early 1980s.

manufacturing industry (two-digit SIC 20-39; 41% of bonds and 22% of bond volume).[17]

There are two notable differences in the industry distribution of PCBs compared to non-subsidized green bonds. First, PCBs are essentially only used by non-financial firms, while non-subsidized green bonds are also widely used by firms in the financial services sector (about 50% of the issuance volume according to figures provided by Flammer, 2021). The application scope of the two types of bonds differs. While there are several eligible purposes for the use of green bonds (see, e.g., International Capital Market Association, 2021), PCBs are designated for investments in (industrial) pollution abatement facilities (see, e.g., Golemon and Burgin, 1983). Second, in relative terms, manufacturing firms are more strongly represented in the PCB issuer sample than in the sample of non-subsidized green bonds used by Flammer (2021).

3.3. Utilization by state

For the pollution control bond dataset, Figure 3 provides a more detailed overview of the utilization by U.S. state. I focus on the boom period of PCB issuance between 1980 and 1984, which is the basis for additional analyses later, and which captures the use of this financing tool prior to regulatory restrictions on issuance later in the sample period.[18] For the state-level plots, I assign pollution control bonds to states based on the headquarters of the issuing firms. During the boom period of PCB issuance, Compustat firms used this type of financing in 43 states. In six states, the total issuance volume exceeded USD 1b between 1980 and 1984: Ohio is the state with the highest usage ($1.50b), followed by Texas ($1.50b), Illinois ($1.43b), California ($1.28b), New York ($1.21b), and Georgia ($1.01b).

3.4. Firm size and the use of pollution control bonds

The U.S. Environmental Protection Agency (1980) points out that PCBs are particularly used by large firms. I analyze how firm size correlates with PCB issuance in my sample.

[17]Within the division transportation and utilities, almost all issuance is from firms in the electric, gas, & sanitary services industry (two-digit SIC code 49).

[18]Appendix Figure B.2 also illustrates issuance by state over the main sample period from 1980 to 2013.

I therefore broadly follow the approach of Chodorow-Reich et al. (2022) and present PCB issuance statistics across the firm-size distribution. Table 2 shows the use of PCBs by firm size quintile, both for size quintiles across industries (Panel A) and for size quintiles within two-digit SIC code industry (Panel B). The key finding is that firm size is positively correlated with PCB issuance.

For Panel A, I divide the sample of Compustat firms into size quintiles based on a firm's average size over the sample period from 1980 to 2013. There are almost no firm years with PCB issuance in the two smallest size quintiles. For the remaining size quintiles, the summary statistics show a strong increase in PCB use with firm size. The largest size quintile captures the vast majority of PCB issuance years.

In Panel B, I divide firms into size quintiles by industry. Even after accounting for potential firm-size differences across industries, PCB issuance increases with firm size. Considering the cost-benefit framework of Lovei (1995), large firms are likely to benefit the most from pollution control bonds as they generally derive greater benefit from pollution abatement investments. For the plant level, Becker and Henderson (2000) for instance note that the enforcement and severity of air quality regulations rise with plant size.

The fact that firm size correlates with tax-subsidized green bond issuance is also a common feature with the non-subsidized corporate green bond market: Flammer (2021) shows that green bond issuers are larger than other bond issuers.

3.5. Other firm characteristics and the use of pollution control bonds

I also test for the correlation between PCB bond issuance and other firm characteristics, controlling for firm size groups. The regression specification is as follows:

$$Characteristic_{i,t-1} = \alpha + \beta PCB\ dummy_{i,t} + \phi_{size,i} + \chi_{j,t} + \psi_{s,t} + \epsilon_{i,t} \tag{1}$$

whereby $Characteristic_{i,t-1}$ are a range of firm characteristics measured in the year before the PCB issuance. $PCB\ dummy_{i,t}$ is a dummy variable equal to one if the respective firm issues a

new money PCB in year t, and zero otherwise. Since I am interested in ex-ante differences in firm characteristics, I only include PCB issuing firms in the years before the bond issuance. $\chi_{j,t}$ are industry-year fixed effects, and $\psi_{s,t}$ denote state-year fixed effects. I add size-by-industry quintile fixed effects ($\phi_{size,i}$) in regressions that capture firms of all size quintiles. Standard errors are clustered at the firm level.

Table 3 presents results for the regression of firm characteristics on the PCB dummy.[19] The sample in Panel A comprises firms in all size-by-industry quintiles. In Panel B, the sample is restricted to firms in the largest size-by-industry quintile. Even when comparing PCB issuers to non-issuers in the same size quintile, I find that PCB issuers are larger in terms of total assets and employment. They also have more tangible assets and display a slightly lower sales growth. PCB issuers in the largest size group have relatively lower cash holdings, which could indicate that they have more restricted internal financial resources (e.g., Accetturo et al., 2024, denote cash holdings as one proxy for internal financial resources). Yet, large PCB issuers they have similar leverage and market-to-book ratios compared to large non-issuers.

4. Conventional corporate bond yields and pollution control bond issuance

In this section, I examine the relation between conventional bond market financing costs and the issuance of tax-subsidized pollution control bonds. I explore how conventional yields are correlated with PCB issuance at both the quarterly aggregate and the firm level. PCBs relatively reduce financing costs for pollution abatement investments compared to financing via conventional debt markets. Intuitively, this relative cost advantage should thus be particularly attractive to firms during periods characterized by high conventional financing costs. Consistent with this, Kreps (1981) anecdotally reports in The Bond Buyer that IBM made its first PCB issuance in the high-interest rate environment of 1981, quoting an IBM spokesman who states "sustained high cost of borrowing" as the underlying reason. Thus, the empirical prediction is

[19]For completeness, Appendix Figure B.3 illustrates the unadjusted difference in means for the same set of firm characteristics.

that new money PCB issuance should be positively associated with conventional bond market yields. For refunding bonds, comparably lower interest rates should, on average, be associated with more refunding activity, so that the correlation between conventional bond yields and refunding bond issuance is likely to be negative.

4.1. Conventional bond yields and aggregate PCB issuance

I test for the correlation between conventional bond yields and aggregate pollution control bond issuance at the calendar-quarter level by running the following regression:

$$PCB\ issuance_q = \alpha + \beta Conventional\ bond\ yield_{q,avg} + \gamma GDP\ per\ cap_{q,lag} + \epsilon_q \qquad (2)$$

whereby $PCB\ issuance_q$ is the natural logarithm of the total number of PCBs issued in the respective quarter plus one, or the total volume of PCBs plus one. I construct these measures separately for new money and refunding bonds. $Conventional\ bond\ yield_{q,avg}$ is the quarterly average of Moody's yield for Aaa-rated corporate bonds as obtained from the Federal Reserve Bank of St. Louis. I control for lagged GDP per cap in all specifications. I also include a recession indicator and calendar-quarter number fixed effects in some specifications. Standard errors are clustered by calendar-quarter number.

Table 4 reports the results of regressing measures of PCB issuance on the average quarterly conventional bond market yield. The table establishes two main results. First, there is a positive correlation between conventional bond yields and new money PCB issuance. Second, there is a negative correlation between conventional bond yields and refunding PCB issuance.

Panel A presents the results for new money PCB issuance and shows that both the number of PCBs (columns 1 and 2) and the volume of PCBs (columns 3 and 4) are positively correlated with conventional bond market yields. In Panel B, I present results for the issuance of refunding bonds. Across all specifications, the conventional bond market yield is negatively correlated with measures of PCB refunding issuance.

For robustness, I examine the correlation of the quarterly average bond market yield for Baa-

rated bonds with measures of PCB issuance. The results are reported in Appendix Table C.1 and support my baseline finding that there is a positive association between conventional bond yields and new money PCB issuance, and a negative association for refunding PCB issuance.

4.2. Conventional bond yields and firm-level PCB issuance

Next, I examine the correlation between conventional bond yields and firm-level measures of pollution control bond issuance. I thereby focus on the sample of firms with at least one PCB issuance between 1980 and 2013. All analyses include firm fixed effects so that the correlation estimates capture within-firm changes in PCB issuance relative to differences in conventional bond yields. All estimations include an indicator variable for recessions as a control variable for the macroeconomic condition. I also include lagged firm size, lagged return on assets, and lagged leverage as firm-level control variables in some of the specifications.

Table 5 reports the results of regressing firm-level measures of pollution control bond issuance on the average annual conventional bond market yield. The table establishes two main findings. First, the correlation of the conventional bond yield with firm-level new money PCB issuance is positive. Second, the respective correlation with refunding bond issuance is negative. The firm-level results are thus consistent with the previous findings for aggregate issuance.

Panel A shows firm-level results for new money bonds. In columns (1) and (2), the dependent variable is the dummy for PCB issuance. In both specifications, I find a positive and statistically significant correlation with conventional bond yields. Focusing on column (2), a one percentage point increase in the conventional bond yield is associated with a 4.1% increase in the probability of issuing a new money PCB. In columns (3) and (4), the measure for firm-level PCB issuance is the natural logarithm of the PCB volume. The point estimates indicate that within-firm, issuance volumes are positively correlated with conventional bond yields. In a robustness test, reported in Appendix Table C.2, I demonstrate that the positive relation between new money PCB issuance and conventional bond market yields is also robust to controlling for decade-specific trends.

Panel B of Table 5 shows firm-level results for refunding bonds. Across all specifications, there is a negative correlation between refunding issuance measures and conventional bond yields.[20]

Overall, the results are consistent with the view that general financing conditions are correlated with the use of pollution control bonds.

5. Pollution control bond issuance and its real effects

Motivated by the documented positive correlation between conventional bond yields and PCB issuance, I analyze whether issuing tax-subsidized green bonds during a period of high interest rates is associated with real effects for the corporate issuers. I examine the association of PCB issuance with sales growth and corporate investment in capital and R&D, respectively. To study the real effects of PCB issuance, I use a difference-in-differences framework. As the period of interest, I use the high-interest rate period from 1980 to 1984. This period is well suited for my analyses for at least two reasons: (i) Because PCB issuance generally grew strongly during these years, many firms probably used PCBs for the first time.[21] (ii) This period is marked by particularly high conventional bond market yields within the 1980 to 2013 time window (see, e.g., Council of Economic Advisers, 2023, Table B–42). From a pollution regulatory perspective, the early 1980s were not characterized by additional strengthening of, for example, air pollution regulation, unlike the 1970s when the Clean Air Act underwent major amendments (see e.g. Reitze, 1999).

Ideally, some firms would randomly issue PCBs in this high-interest rate period, and others not. I am not aware of such an experimental setting, so it is endogenous which firms are PCB issuers in the difference-in-differences framework. Therefore, I proceed as follows: I define treated firms as those that tap the PCB bond market during the period 1980 to 1984. Then, to construct a counterfactual for these firms, I follow the approach of Flammer (2021) and use a nearest neighbor matching strategy, which also requires exact matching of some characteristics.

[20] When controlling for decade-specific trends as reported in Appendix Table C.2, the point estimates are still negative, but not statistically significant anymore.

[21] IBM's first PCB issuance in 1981 is a good example. See Kreps (1981) for details.

5.1. Matching and difference-in-differences specification

I examine real effects for firms that tap the PCB market between 1980 and 1984 relative to group of matched control firms that never issued a pollution control bond until 2013. Control firms may therefore be considered as "never treated" with respect to the use of PCBs for the more broader sample period considered in the above analyzes. As the basis for matching, I use the firm characteristics as of 1979, which implies that the matching characteristics predate both the boom period of PCB issuance and the high-interest rate period itself. For the matching process, I start with the group of non-PCB issuing firms in Compustat that are used as a broad comparison group for the analysis of issuer firm characteristics (see Section 3).[22]

Starting with this sample of potential control firms, I take a two-step approach. In the first step, I impose additional data availability requirements. I remove firm years with missing information on sales growth, which is the main dependent variable in the real effects analyses. Furthermore, I require data availability for the firm in at least half of the years between 1977 and 1987.[23] In the second step, I select the variables for the matching process and conduct the matching. The selection of variables is guided by the stylized facts on the use of PCBs presented in Section 3. In particular, I require an exact matching of the two-digit SIC code and the headquarter state. This ensures that PCBs and their matched control firms are exposed to the same industry and state-level economic conditions as well as regulatory environments (Flammer, 2021). In a robustness test, I also require exact matching of the size-by-industry quintile. The nearest neighbor for each PCB issuer is then determined based on the Mahalanobis distance, which is calculated using the following five matching variables: size, return on assets, the capex-to-assets ratio, the property, plant, and equipment-to-assets ratio, and sales growth.

The matched sample comprises 149 new money—thus, new abatement project—PCB issuers PCB issuers and 149 control firms.[24] If a firm issues multiple bonds between 1980 and 1984, I focus only on the first issue year as the treatment year. Appendix Table C.3 shows the

[22] I already impose several restrictions on this group of firms as described in Section 2.1.

[23] Because of the different issuance years considered, this is ultimately the time frame from which the financial data for the sample is derived.

[24] There are 189 unique PCB issuers between 1980 and 1984. However, due to the exact matching requirement for industry and state, not all of them can be matched to a control firm.

descriptive statistics prior to issuance for the group of PCB issuers and the matched control firms and compares the similarity of the two groups. There is no pre-issuance difference with respect to the outcome variables sales growth and R&D-to-assets. For capital investment, PCB issuers display a slightly higher capex-to-assets ratio. In addition, PCB issuers are larger than the control group in terms of assets and employment.[25]

For the matched sample, I consider a window of plus/minus three years around the year of PCB issuance (henceforth year 0) and run the following difference-in-differences regressions:

$$\begin{aligned} Y_{i,t} = \alpha + \beta Post\ issuance_t \cdot PCB\ issuer_{new\ money,i} + \gamma Post\ issuance_t \\ + \delta PCB\ issuer_{new\ money,i} + \xi_i + \chi_t + \psi_y + \epsilon_{i,t} \end{aligned} \tag{3}$$

whereby i denotes a firm, and t are event time-years around the issuance. ψ_y is a fixed effect for the issuance year cohort, thus capturing the firms that issue a PCB in a respective year as well as their matched control firms. The outcome variable Y is either sales growth, the capex-to-assets ratio, or the R&D-to-assets ratio. *Post issuance* equals one in the three years following the PCB issuance (i.e., from year 1 to year 3). *PCB issuer* is a treatment dummy set to one if the respective firm issues a PCB bond between 1980 and 1984. I control for the lag of size, lag of return on assets, and lag of leverage in all regressions. In some specifications, I control for state-by-issue year (i.e., state-by-issue year cohort) and industry-by-year fixed effects. Standard errors are clustered at the firm level. The variable of interest is the coefficient on the interaction term *Post issuance x PCB issuer*. In the empirical estimation, the variables *Post issance* and *PCB issuer* are absorbed by event time and firm fixed effects, respectively.

5.2. Pollution control bond issuance and corporate sales growth

Table 6 presents the results of difference-in-differences regressions for the association between PCB issuance and sales growth. The key finding is that PCB issuance is positively associated with sales growth after the bond issuance. Across all specifications, the point estimate for the

[25] Among other control variables, I control for the lag of size in all regressions.

interaction term *PCB issuer x Post issuance* is positive and statistically significant, ranging from 0.024 to 0.030. These estimates indicate that PCB issuers display a relative increase in sales growth by 2.4% to 3.0% over the three-year post-issuance window. With an average sales growth rate in the sample of 9%, this implies a relative increase by 0.22 to 0.27 percentage points for the average firm.

Figure 4 illustrates the development of sales growth over the event window. Subfigure (a) shows the development of the average sales growth for PCB issuers and the matched control group from three years before to three years after the PCB issuance year (year 0). Both groups show a similar trend in sales growth up to the year of issuance.[26] After the issue year, sales growth rates continue to decline for both groups, but the decline is relatively smaller for the group of PCB issuers. Subfigure (b) shows the coefficient estimates and the 90% confidence interval on the PCB issuer dummy interacted with event time dummies. The regression specification follows column (3) in Table 6, which includes state-issue year and industry-year fixed effects beyond the baseline specification outlined in equation 3. There is no difference in sales growth until the PCB issuance year. The relative increase in sales growth starts in the year after the bond issue and remains almost constant until the end of the three-year post-issuance window that is examined.

Overall, PCB issuance appears to be positively associated with sales growth after a bond issuance during the high-interest rate period of the early 1980s. This suggests that using a low-cost source of financing for green investments can be associated with positive economic aspects for the respective firms. Note that these estimates are based on a sample of PCB issuers and a matched control group. While the matching process increases the comparability between PCB issuers and non-issuers and the groups show similar pre-issuance sales growth trends, the matching process cannot account for the selection effect associated with PCB issuance. Thus, the results do not imply a causal relation.

[26]Note that sales growth is used as a matching variable when constructing the control group. The similar pre-issuance trend is thus consistent with a balancing of this characteristic in the matching process.

5.3. Volume of pollution control bonds and corporate sales growth

To capture how the actual PCB issuance volume is associated with sales growth, I use the logarithm of the PCB issuance volume instead of the PCB issuer dummy as the issuance measure in the difference-in-differences framework. Table 7 presents the results. The main finding is that the PCB issuance volume is positively associated with sales growth after the bond issuance, supporting the baseline results using the PCB issuer dummy. In particular, the point estimate is positive and statistically significant in all specifications, even after controlling for industry-year trends and potential shocks at the state-issuance year level in the most restrictive specification (column 3). Appendix Figure B.4 illustrates the time dynamics for the latter specification. Again, I observe no difference in sales growth until the year of the bond issue (year 0). The relative increase in sales growth for PCB issuers begins in the year after the issuance and reaches its maximum at the end of the three-year post-issuance window that is examined.

5.4. Robustness tests

I conduct a number of robustness tests to support my baseline finding that PCB issuance during the high-interest rate period of the early 1980s is positively associated with post-issuance sales growth. Appendix Table C.4 and Appendix Table C.5 present the results.

In the first test, I show that the positive association between PCB issuance and sales growth is robust to considering only PCB issuers that tap the PCB market between 1980 and 1982 and their matched control firms. While conventional bond market yields were still high in absolute terms in 1983 and 1984, they were somewhat lower compared to the 1981 peak for Moody's Aaa-rated bonds and the 1982 peak for Baa-rated bonds, respectively (see Council of Economic Advisers, 2023, Table B-42, for the corresponding data).[27] The issue year restriction reduces the sample to 228 firms, with 114 PCB issuers. In all specifications, I obtain positive and statistically significant point estimates for the interaction term *PCB issuer x Post issuance* (Panel A) or *PCB volume x Post issuance* (Panel B), except for the baseline specification using

[27]November 1982 also marks the end of the 1981 to 1982 recession period (see, e.g., Sablik, 2013).

the PCB issuer dummy (Panel A, column 1). Focusing on Panel A, the point estimates imply a relative increase in sales growth by 1.8% to 2.3% for PCB issuers, which is slightly less pronounced compared to the baseline estimates presented in Table 6.

In the second test, I show that the positive association between PCB issuance and sales growth is robust to a more restrictive construction of the control group, which also requires an exact matching of the size-by-industry quintile. Since such an exact size group match is not available for all PCB issuing firms captured in the baseline sample, the sample is reduced to 188 firms with 94 PCB issuers. For this matched sample, Appendix Table C.3, Panel B, presents the pre-issuance characteristics and between-group differences. Compared to the baseline matched sample, the additional exact matching on the size-by-industry quintile reduces the mean difference for the logarithm of total assets and employment, although the differences remain statistically significant. In all regressions, the point estimate obtained for the interaction term between the respective measure for PCB issuance and the Post issuance dummy is positive and statistically significant, even when size quintile-by-year fixed effects that control for the development of the different firm size groups over time are included (column 4).

Overall, the results of the robustness tests support the baseline finding that firms that issue PCBs during the high-interest rate period of the early 1980s display an increase in output after the bond issue.

5.5. Pollution control bond issuance and corporate investment

The proceeds of pollution control bonds are used for investment in pollution abatement facilities. Is the issuance of pollution control bonds also associated with a change in capital investment or R&D investment? I use the difference-in-differences framework outlined in Section 5.1 to examine this relation. Capital investment is measured as capex divided by the beginning of period total assets, and R&D investment is measured as R&D expenses divided by the beginning of period total assets. I further consider R&D $\text{investment}_{\text{imputed}}$ as a measure for

which I replace the missing values with zero.[28]

Table 8 presents the results of difference-in-differences regressions for the association between PCB issuance and corporate investment. There are two key findings. First, I find no statistically significant association of PCB issuance with capital investment. Second, I find that PCB issuance is positively associated with R&D investment post-issuance. Focusing on the result for R&D investment at the intensive margin as displayed in Panel A, column (3), the point estimate for the interaction term *PCB issuer x Post issuance* equals 0.0034 and is statistically significant. This indicates that PCB issuers display a relative increase in the R&D-to-assets ratio of 0.34 percentage points over the three-year window after bond issuance. For the interaction term *PCB volume x Post issuance* (Panel B), the point estimate in column (3) is positive, but not statistically significant (t-stat: 1.4284).[29]

To summarize, PCB issuance during the high-interest rate period from 1980 to 1984 appears to be positively associated with R&D investment, while I do not find any statistically significant association with capital investment. As outlined earlier, note that these estimates do not imply a causal relation.

6. Conclusion

This paper examines the use and the corporate real effects of green bonds that are tax-subsidized and thus a source of low-cost financing for green projects. It therefore introduces a comparably large sample of tax-exempt pollution control bonds issued between 1980 and 2013 which finance pollution control facilities of U.S. public firms.

I first present several facts about firms' use of tax-subsidized PCBs. I show that these bonds are used disproportionately by large firms, even within industries. Further, I document that PCBs are primarily used by firms in the manufacturing and utility industries. With respect to

[28]Due to restricted data availability for R&D and the correspondingly smaller sample size, I use industry division instead of two-digit SIC codes to construct industry-year fixed effects for all investment regressions.

[29]Appendix Figure B.5 illustrates the time dynamics of the association between PCB issuance and firms' R&D investment, following the regression specifications as displayed in column (2). I observe no difference in R&D investment in the years prior to the PCB issuance (year 0). Firms that issue a PCB display a relative increase in R&D investment after the PCB is issued. The positive association reaches its maximum two years after the PCB issuance, and slightly decreases thereafter.

the use of PCBs over time, bond issuance peaked in the first half of the 1980s.

Then, I document that PCB issuance is correlated with the cost of conventional bond financing: New money bond issuance, which finances new projects, is positively correlated with conventional bond yields, while refunding bond issuance shows a negative correlation.

Finally, I analyze how the issuance of PCBs is associated with sales growth. Comparing firms that issue PCBs during the period of high interest rates between 1980 and 1984 with a matched control group, I find that firms using PCBs display a relative increase in sales growth after issuance. From the perspective of corporate issuers, this output effect highlights a potential positive economic aspect associated with undertaking tax-subsidized green investments.

While the focus of this paper is on the financing cost reduction aspect of PCBs, a natural follow-up question concerns the overall environmental impact of these bonds. Thus, my findings motivate further research on the overall environmental benefit of such bonds and, more broadly, on the role that tax-subsidized green bonds could play as part of an environmental policy mix.

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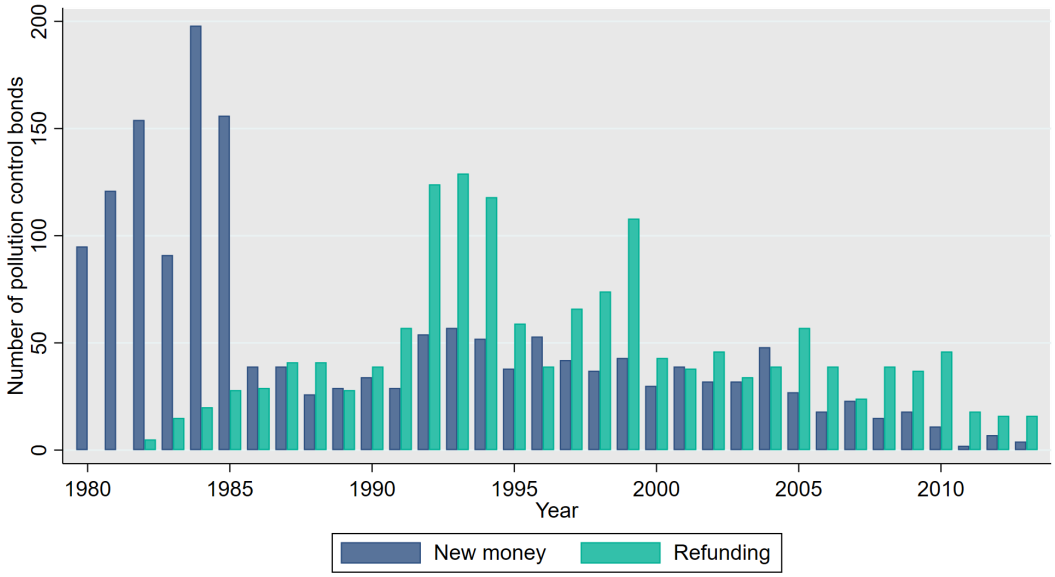
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Figure 1
Issuance of tax-subsidized pollution control bonds over time

This figure illustrates the issuance of pollution control bonds by firms covered in Compustat over time. I separately show the issuance of new money bonds (■) and refunding bonds (■) per calendar year. Subfigure (a) shows the development of the number of bonds over the sample period from 1980 to 2013. Subfigure (b) shows the development of the total annual issuance volume.

(a) Number of pollution control bonds over time



(b) Volume of pollution control bonds over time

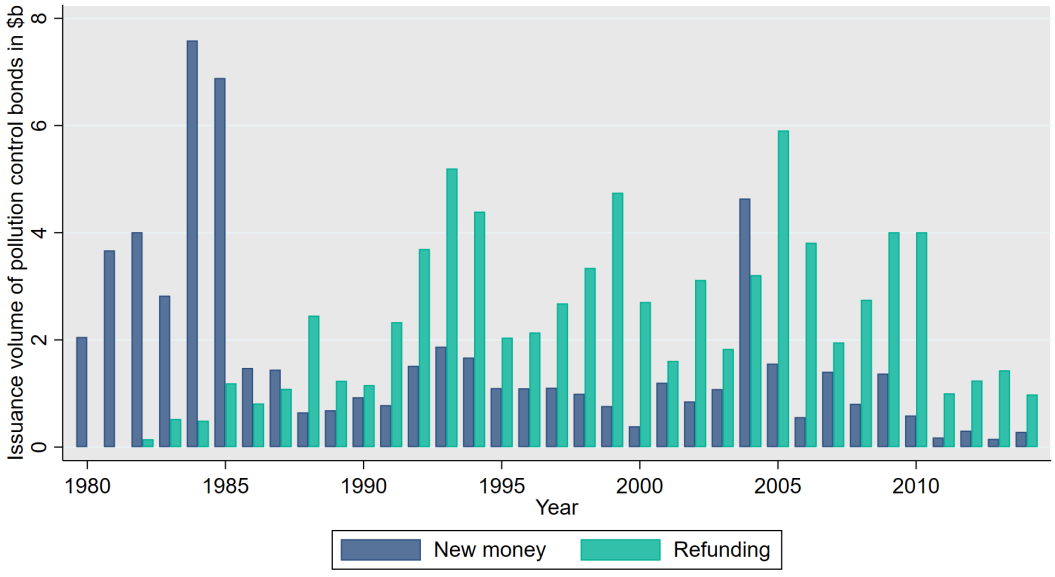
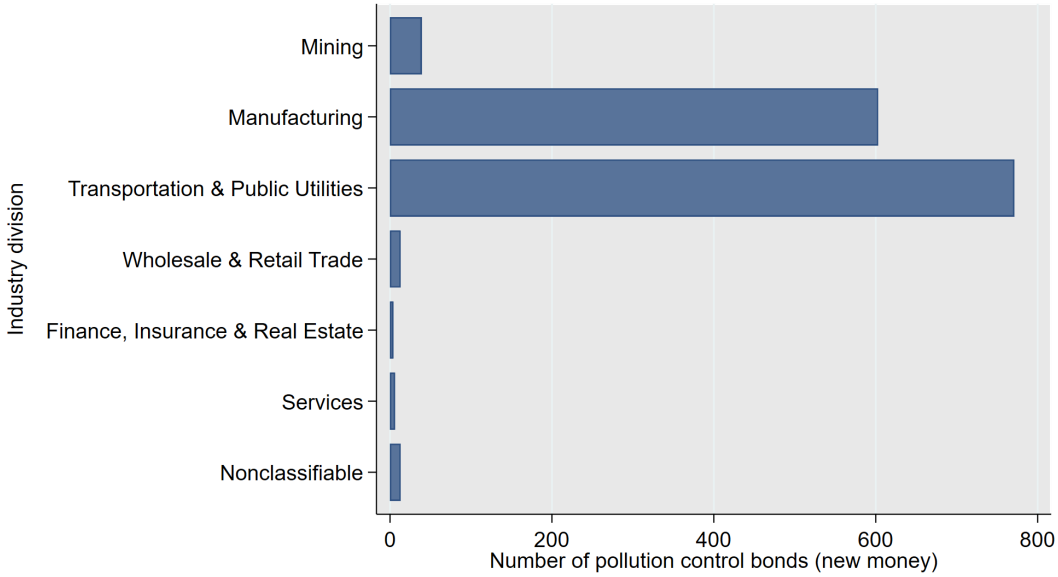


Figure 2
Issuance of tax-subsidized pollution control bonds by industry division

This figure illustrates the issuance of pollution control bonds at the industry division level (based on two-digit SIC codes). The sample consists of all new money PCBs issued between 1980 and 2013 by firms covered in Compustat. Subfigure (a) shows the total number of bonds by industry division. Subfigure (b) shows the total issuance volume of bonds by industry division, adjusted for inflation and expressed in 2013 USDb.

(a) Number of pollution control bonds by industry divison



(b) Issuance volume of pollution control bonds by industry division

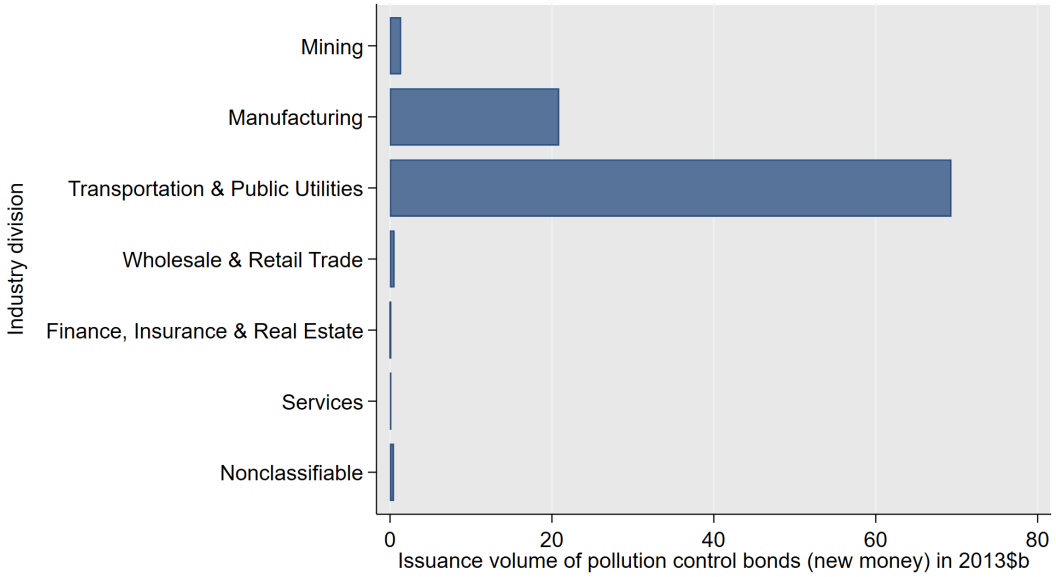
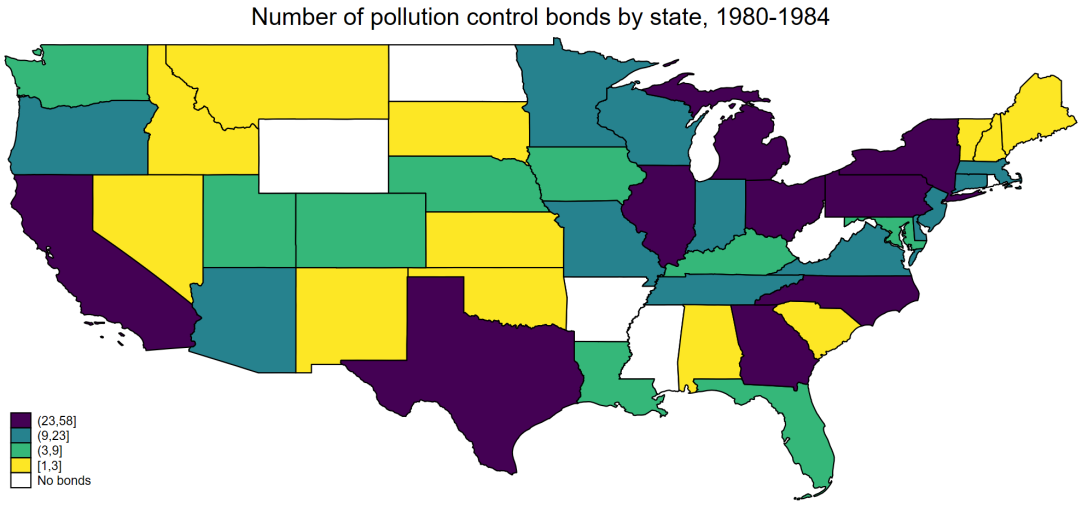


Figure 3

Issuance of tax-subsidized pollution control bonds by state between 1980 and 1984

This figure illustrates the issuance of pollution control bonds by state, based on the location of the issuing firms' headquarters. The sample consists of new money PCBs issued by Compustat firms between 1980 and 1984. States marked in white have no PCB issues between 1980 and 1984. States marked in yellow (■) are in the bottom quartile in terms of total state-level PCB issuance. States marked in green (■) are in the second quartile regarding total PCB issuance. States marked in blue are in the third quartile (■), while states marked in violet (■) are in the top quartile of states in terms of total PCB issuance. Subfigure (a) shows the map for the total number of bonds by state. Subfigure (b) shows the map for the total issuance volume of bonds by state (not adjusted for inflation).

(a) Number of pollution control bonds by state



(b) Issuance volume of pollution control bonds by state

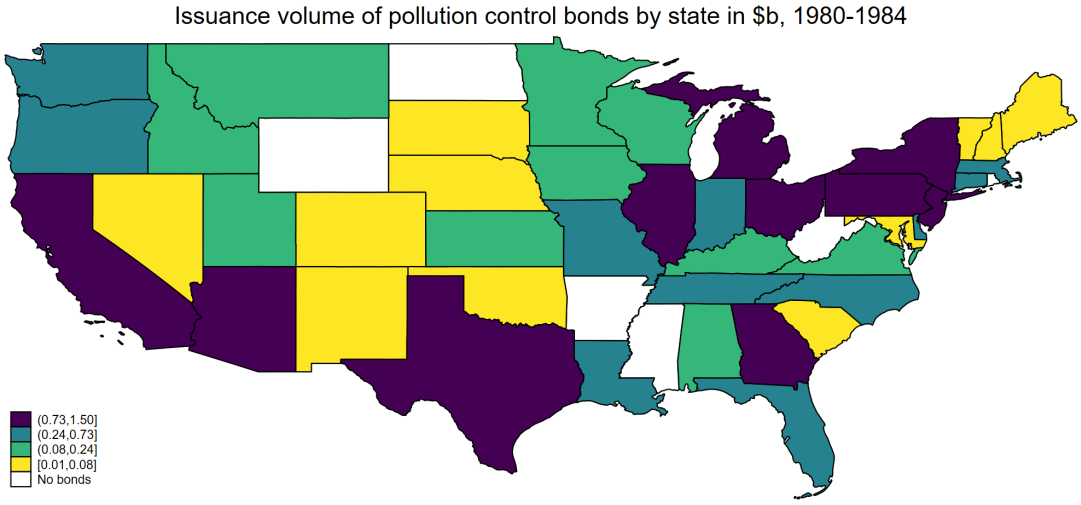
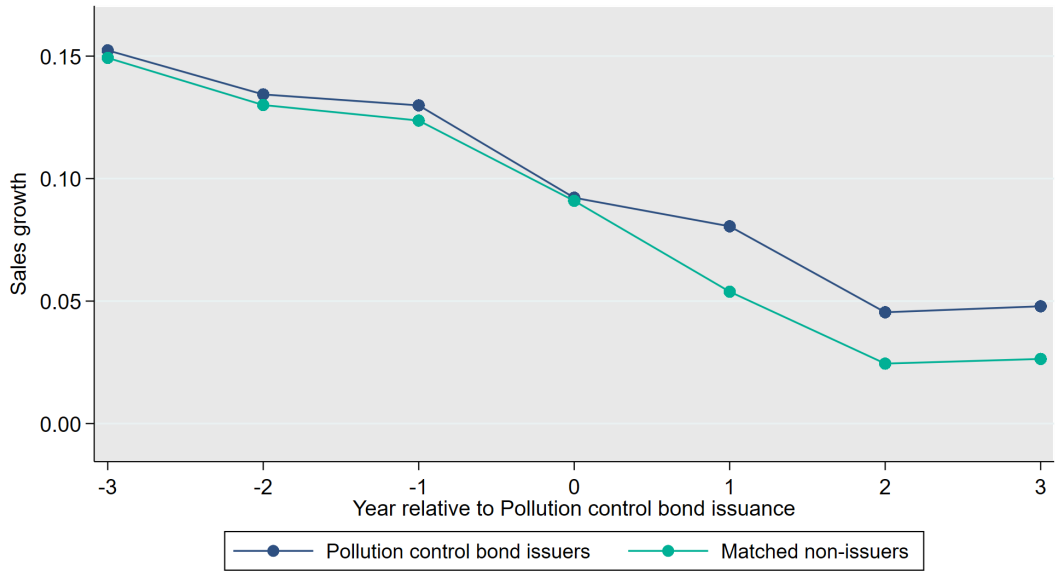


Figure 4
Pollution control bond issuance and firms' sales growth

This figure illustrates the development of sales growth for firms that issue pollution control bonds between 1980 and 1984, and a matched control group. The matching process is described in Section 5.1. Sales growth is measured as the difference in log(sales) between year t and year t-1. Subfigure (a) shows the development of average sales growth for firms issuing pollution control bonds (●) compared to the matched control group (●) over a seven year window from three years before to three years after the year of PCB issuance (year 0). Subfigure (b) shows the coefficient estimates and the 90% confidence interval on the PCB issuer dummy interacted with event time dummies. The regression specification follows column (3) in Table 6. Appendix A provides a detailed description of all variables.

(a) Mean values of sales growth



(b) Difference in sales growth

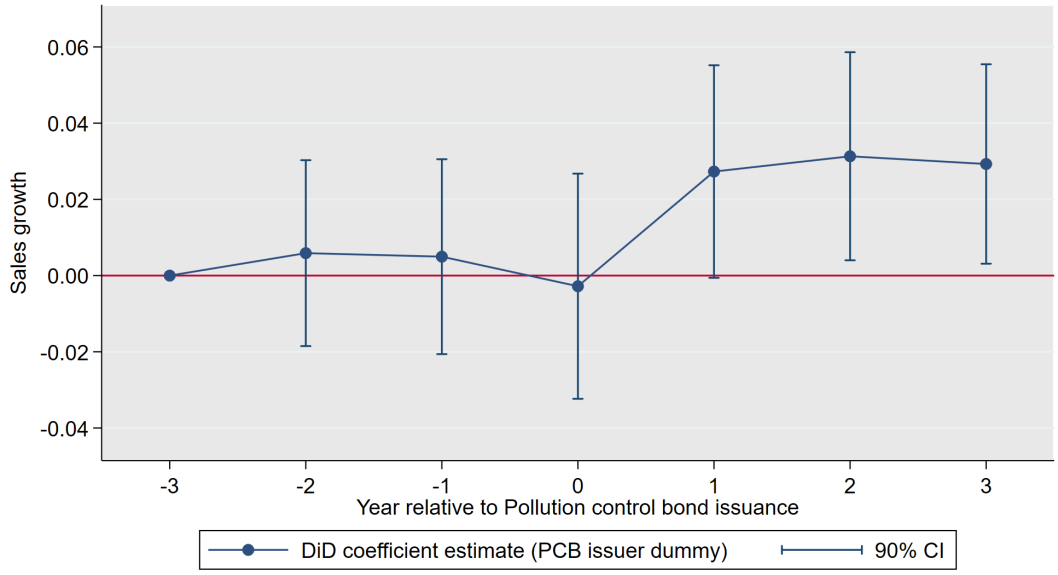


Table 1

Descriptive statistics

This table presents descriptive statistics at the bond-, firm-, and quarterly aggregate level, based on pollution control bond issues between 1980 and 2013 by firms covered in Compustat. Panel A shows descriptive statistics for PCB issuance at the bond deal level for new money and refunding bonds. Panel B shows descriptive statistics for PCB issuance at the calendar-quarter level. The sample covered in Panel C comprises 313 firms with any PCB issuance during the sample period from 1980 to 2013. Panel D comprises PCB issuers that tap the PCB market during the high-interest rate period between 1980 and 1984 and their matched control firms. Appendix A provides a detailed description of all variables.

	N	Mean	SD	25^{th}	50^{th}	75^{th}
Panel A: Bond deal-level characteristics						
Bond deal volume$_{\text{new money}}$ (2013$m)	1,693	64.42	84.20	15.24	34.55	79.57
Rated dummy$_{\text{new money}}$	1,693	0.76	0.43	1.00	1.00	1.00
Callable dummy$_{\text{new money}}$	1,578	0.84	0.36	1.00	1.00	1.00
Maturity$_{\text{new money}}$ (years)	1,687	26.13	12.82	20.00	30.00	30.00
Bond deal volume$_{\text{refunding}}$ (2013$m)	1,507	73.64	81.93	18.71	48.21	99.79
Panel B: Quarterly aggregate sample						
PCB number$_{\text{new money}}$	136	12.45	15.75	4.00	8.00	14.00
Aggregate PCB volume$_{\text{new money}}$ (2013$m)	136	801.93	1339.87	156.72	355.06	844.50
PCB number$_{\text{refunding}}$	124	12.15	9.41	6.00	10.00	16.00
Aggregate PCB volume$_{\text{refunding}}$ (2013$m)	124	894.96	704.43	335.64	698.07	1,341.19
Conventional bond yield$_{\text{q, avg}}$	136	7.88	2.76	5.62	7.40	9.40
Recession dummy$_{\text{q}}$	136	0.13	0.34	0.00	0.00	0.00
Panel C: Firm-level sample of pollution control bond issuers						
PCB dummy$_{\text{new money}}$	7,849	0.11	0.31	0.00	0.00	0.00
PCB volume$_{\text{new money}}$ (2013$m)	846	108.65	177.87	26.04	57.24	125.65
Log(PCB volume$_{\text{new money}}$)	7,849	0.44	1.31	0.00	0.00	0.00
Lag of Size	7,849	8.14	1.42	7.36	8.19	9.16
Lag of RoA	7,849	0.13	0.06	0.09	0.12	0.15
Lag of Leverage	7,849	0.50	0.26	0.39	0.51	0.59
Conventional bond yield$_{\text{y, avg}}$	7,849	8.21	2.71	5.67	7.59	9.38
Recession dummy$_{\text{y}}$	7,849	0.24	0.43	0.00	0.00	0.00
PCB dummy$_{\text{refunding}}$	7,045	0.10	0.30	0.00	0.00	0.00
PCB volume$_{\text{refunding}}$ (2013$m)	682	146.18	217.91	33.78	79.41	159.50
Log(PCB volume$_{\text{refunding}}$)	7,045	0.42	1.33	0.00	0.00	0.00
Panel D: PCB issuers and matched control firms						
PCB issuer$_{\text{new money}}$	2,068	0.50	0.50	0.00	0.00	1.00
PCB volume$_{\text{new money}}$($m, not inflation-adjusted)	2,068	18.19	31.99	0.00	0.00	22.25
Log(PCB volume$_{\text{new money}}$)	2,068	1.58	1.73	0.00	0.00	3.15
Sales growth	2,068	0.09	0.12	0.03	0.10	0.16
Capex/Assets	2,065	0.10	0.05	0.07	0.09	0.13
R&D/Assets$_{\text{imputed}}$	2,068	0.01	0.02	0.00	0.00	0.00
R&D/Assets	541	0.03	0.03	0.01	0.02	0.04

Table 2

Firm size and pollution control bond issuance

This table presents summary statistics of new money PCB issuance by firm size group. In Panel A, I divide the sample of Compustat firms into five size quintiles based on a firm's average size over the sample period from 1980 to 2013. Size quintile 1 captures the group of smallest firms, while quintile 5 captures the group of largest firms. In Panel B, I split firms into size quintiles by industry. 1 refers to the smallest firms within a two-digit SIC industry, and 5 refers to the largest firms, respectively. Size is measured as the natural logarithm of total assets one plus. The table further reports the average firm size within a size quintile, the number of firm years with a PCB issuance, and the average PCB volume issued in those firm years. Appendix A provides a detailed description of all variables.

	# Firm years	Total assets (mean, 2013$m)	# PCB issuance firm years	PCB volume (mean, 2013$m)
Panel A: Size quintile				
1	29,862	11.94	1	11.43
2	29,960	56.58	1	6.97
3	29,980	193.43	10	19.58
4	29,953	801.95	43	32.16
5	29,954	8,447.74	791	114.19
Panel B: Size-by-industry quintile				
1	27,834	28.53	8	20.1
2	27,803	170.35	18	34.29
3	27,846	495.07	126	73.73
4	27,869	1,432.50	170	95.23
5	27,361	7,640.86	524	125.31

Table 3

Characteristics of corporate pollution control bond issuers

This table presents the results for the regression of firm characteristics on a dummy for PCB issuance. The regression specification follows equation 1. The characteristic variable (dependent variable) is indicated in each column and is measured in t-1. All regressions include industry-year and state-year fixed effects. PCB $\text{dummy}_{\text{new money}}$ is a dummy variable that equals one if the respective firm issues a new money pollution control bond in year t, and zero otherwise. In Panel A, the sample comprises firms in all size-by-industry quintiles. These regressions additionally control for size-by-industry quintile fixed effects. In Panel B, the sample is restricted to firms in the largest size-by-industry quintile. T-statistics based on Huber/White robust standard errors clustered by firm are presented in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	(1) Log(Assets)	(2) Log(Emp)	(3) PPE/Assets	(4) RoA	(5) Market-to-Book	(6) Payout ratio	(7) Leverage	(8) Sales growth	(9) Cash/Assets	(10) Capex/Assets
Panel A: Firms in all size-by-industry quintiles										
PCB $\text{dummy}_{\text{new money}}$	0.621***	0.534***	0.108***	-0.084***	-0.061	0.042	-0.007	-0.038***	-0.004	0.006
	(5.911)	(6.637)	(9.512)	(-8.080)	(-1.053)	(1.198)	(-0.527)	(-6.362)	(-0.267)	(1.585)
Size-by-ind. quintile FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	125,770	115,545	116,161	125,787	104,964	116,704	125,787	115,852	116,230	115,119
Adjusted R^2	0.806	0.620	0.410	0.236	0.166	0.0479	0.0480	0.0671	0.139	0.171
Panel B: Firms in largest size-by-industry quintile										
PCB $\text{dummy}_{\text{new money}}$	0.943***	0.630***	0.077***	0.008	-0.007	0.196***	-0.023	-0.022**	-0.027**	0.013**
	(6.183)	(4.884)	(3.882)	(1.339)	(-0.099)	(3.600)	(-1.189)	(-2.002)	(-2.065)	(2.366)
Industry x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	22,169	20,796	20,889	22,169	18,551	20,670	22,169	22,099	20,908	20,759
Adjusted R^2	0.414	0.252	0.517	0.0690	0.169	0.0183	0.0917	0.141	0.143	0.258

Table 4

Conventional bond yields and aggregate pollution control bond issuance

The table reports the results of regressing measures of pollution control bond issuance on the average quarterly conventional bond market yield. All regressions are at the calendar-quarter level and follow the specification of equation 2. Conventional bond yield is the quarterly average of Moody's yield for Aaa-rated corporate bonds in percent, obtained from the Federal Reserve Bank of St. Louis. In Panel A, the dependent variables are the natural logarithm of the quarterly number of new money PCBs plus one (columns 1 and 2), and the natural logarithm of the quarterly total volume of new money PCBs plus one (columns 3 and 4), respectively. The sample period is from 1980 to 2013. Panel B uses the same measures of pollution control bond issuance for refunding bonds. For Panel B, the sample period is from 1983 to 2013. T-statistics based on Huber/White robust standard errors clustered by calendar-quarter number are presented in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	(1)	(2)	(3)	(4)
Panel A: Issuance of new money pollution control bonds				
	Log(Bond number$_{\text{new money}}$)		Log(Aggregate volume$_{\text{new money}}$)	
Conventional bond yield$_{\text{q, avg}}$	0.170**	0.165**	0.266***	0.249***
	(4.475)	(5.752)	(9.683)	(7.723)
Calendar-quarter nr. FE	No	Yes	No	Yes
Lag of GDP per cap	Yes	Yes	Yes	Yes
Recession indicator	No	Yes	No	Yes
Number of observations	136	136	136	136
Adjusted R^2	0.425	0.539	0.391	0.414
Panel B: Issuance of refunding pollution control bonds				
	Log(Bond number$_{\text{refunding}}$)		Log(Aggregate volume$_{\text{refunding}}$)	
Conventional bond yield$_{\text{q, avg}}$	-0.294***	-0.336***	-0.261**	-0.315*
	(-6.550)	(-7.494)	(-4.066)	(-3.177)
Calendar-quarter nr. FE	No	Yes	No	Yes
Lag of GDP per cap	Yes	Yes	Yes	Yes
Recession indicator	No	Yes	No	Yes
Number of observations	124	124	124	124
Adjusted R^2	0.102	0.168	0.0240	0.101

Table 5

Conventional bond yields and firm-level pollution control bond issuance

The table reports the results of regressing firm-level measures of pollution control bond issuance on the average annual conventional bond market yield. The sample includes Compustat firms with at least one PCB issuance during the sample period from 1980 to 2013. Conventional bond yield is the quarterly average of Moody's yield for Aaa-rated corporate bonds in percent, obtained from the Federal Reserve Bank of St. Louis. In Panel A, the dependent variables are the dummy for PCB issuance (columns 1 and 2), and the natural logarithm of the annual new money PCB volume plus one (columns 3 and 4), respectively. Panel B uses the same firm-level measures of pollution control bond issuance for refunding bonds. For Panel B, the sample period is from 1983 to 2013. Firm controls include lag of size, lag of return on assets, and lag of leverage. T-statistics based on Huber/White robust standard errors clustered by firm are presented in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	(1)	(2)	(3)	(4)
Panel A: Firm-level issuance of new money pollution control bonds				
	PCB dummy$_{\text{new money}}$		Log(PCB volume$_{\text{new money}}$)	
Conventional bond yield$_{\text{y,avg}}$	0.030***	0.041***	0.136***	0.187***
	(12.619)	(13.294)	(12.044)	(12.837)
Recession dummy	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes
Number of observations	7,849	7,849	7,849	7,849
Adjusted R^2	0.137	0.146	0.149	0.160
Panel B: Firm-level issuance of refunding pollution control bonds				
	PCB dummy$_{\text{refunding}}$		Log(PCB volume$_{\text{refunding}}$)	
Conventional bond yield$_{\text{y,avg}}$	-0.004**	-0.005**	-0.021***	-0.025***
	(-2.242)	(-2.072)	(-3.172)	(-2.705)
Recession dummy	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes
Number of observations	7,045	7,045	7,045	7,045
Adjusted R^2	0.0734	0.0732	0.0868	0.0867

Table 6

Pollution control bond issuance and firms' sales growth

The table reports the results of difference-in-differences regressions for the association between PCB issuance and sales growth. The specification follows equation 3 and compares PCB issuers that tap the PCB market between 1980 and 1984 with a matched control group. The dependent variable sales growth is measured as the difference in log(sales) between year t and year t-1. Post issuance is a dummy that equals one in the three years following the firm's first PCB issuance. PCB issuer$_{\text{new money}}$ is a dummy that equals one if the firm issues any PCB between 1980 and 1984. The sample period is from three years before the PCB issuance to three years thereafter. T-statistics based on Huber/White robust standard errors clustered by firm are presented in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	(1)	(2)	(3)
	Sales growth		
PCB issuer$_{\text{new money}}$ x Post issuance	0.024**	0.030***	0.028***
	(2.436)	(2.893)	(3.257)
Lag of Size	-0.105***	-0.113***	-0.095***
	(-4.693)	(-4.881)	(-4.308)
Lag of RoA	-0.237**	-0.185	-0.271**
	(-2.012)	(-1.492)	(-1.985)
Lag of Leverage	0.085	0.106*	0.063
	(1.494)	(1.834)	(1.061)
Firm FE	Yes	Yes	Yes
Event time FE	Yes	Yes	Yes
Issue year FE	Yes	No	No
State x Issue year FE	No	Yes	Yes
Industry x Year FE	No	No	Yes
Number of observations	2,068	1,921	1,907
Adjusted R^2	0.203	0.161	0.391

Table 7

Pollution control bond issuance and firms' sales growth: effect of issuance volume

The table reports the results of difference-in-differences regressions for the association between PCB issuance volume and sales growth. The specification follows equation 3 but uses PCB volume as the treatment measure instead of the PCB issuer dummy. PCB volume is measured as the natural logarithm of the volume of the first PCB issuance between 1980 and 1984 plus one, and is zero for the matched control group. The dependent variable sales growth is the difference in log(sales) between year t and year t-1. Post issuance is a dummy that equals one in the three years following the firm's first PCB issuance. Firm controls are lag of size, lag of return on assets, and lag of leverage. The sample period is from three years before the PCB issuance to three years thereafter. T-statistics based on Huber/White robust standard errors clustered by firm are presented in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	(1)	(2)	(3)
	Sales growth		
Log(PCB volume$_{\text{new money}}$) x Post issuance	0.008***	0.010***	0.009***
	(2.819)	(3.269)	(3.722)
Firm controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Event time FE	Yes	Yes	Yes
Issue year FE	Yes	No	No
State x Issue year FE	No	Yes	Yes
Industry x Year FE	No	No	Yes
Number of observations	2,068	1,921	1,907
Adjusted R^2	0.204	0.162	0.392

Table 8

Pollution control bond issuance and corporate investment

The table reports the results of difference-in-differences regressions for the association between PCB issuance and capital investment (column 1), zero-imputed R&D investment (2), and R&D investment (3). Capital investment is the capex-to-assets ratio, and R&D investment is the R&D-to-assets ratio. For column 2, missing values are replaced by zero. Other than that, the specification follows equation 3 and compares PCB issuers that tap the PCB market between 1980 and 1984 with a matched control group. Post issuance is a dummy that equals one in the three years following the firm's first PCB issuance. PCB $\text{issuer}_{\text{new money}}$ is a dummy that equals one if the firm issues any PCB between 1980 and 1984. Log($\text{PCB volume}_{\text{new money}}$) is the natural logarithm of the volume of the first PCB issuance between 1980 and 1984 plus one, and is zero for the matched control group. Firm controls are lag of size, lag of return on assets, and lag of leverage. The sample period is from three years before the PCB issuance to three years thereafter. T-statistics based on Huber/White robust standard errors clustered by firm are presented in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	(1)	(2)	(3)
	Capex/Assets	$\text{R\&D/Assets}_{\text{imputed}}$	R&D/Assets
Panel A: PCB issuer dummy			
$\text{PCB issuer}_{\text{new money}}$ x Post issuance	-0.0069	0.0011**	0.0034*
	(-1.3200)	(2.5027)	(1.7676)
Firm controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Event time FE	Yes	Yes	Yes
State x Issue year FE	Yes	Yes	Yes
Industry division x Year FE	Yes	Yes	Yes
Number of observations	1,918	1,921	472
Adjusted R^2	0.498	0.976	0.963
Adjusted R^2 (within)	0.0823	0.0554	0.127
Panel B: PCB volume			
Log($\text{PCB volume}_{\text{new money}}$) x Post issuance	-0.0014	0.0003**	0.0009
	(-0.9903)	(2.3507)	(1.4284)
Firm controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Event time FE	Yes	Yes	Yes
State x Issue year FE	Yes	Yes	Yes
Industry division x Year FE	Yes	Yes	Yes
Number of observations	1,918	1,921	472
Adjusted R^2	0.497	0.975	0.963
Adjusted R^2 (within)	0.0812	0.0509	0.118

A. Variable Definitions

Variable	Description
Measures for pollution control bond issuance	
Bond number$_{\text{new money}}$	Sum of new money PCBs issued during the indicated time period. Source: SDC Platinum.
Aggregate volume$_{\text{new money}}$	Sum of new money PCB issuance volume during the indicated time period. Source: SDC Platinum.
PCB dummy$_{\text{new money}}$	Dummy which equals one if the firm issues a PCB new money bond in the respective year. Source: SDC Platinum.
PCB volume$_{\text{new money}}$	Firm-level issuance volume of new money PCBs. Source: SDC Platinum.
PCB issuer$_{\text{new money}}$	Dummy which equals one if the firm issues any new money PCB between 1980 and 1984. Source: SDC Platinum.
Bond number$_{\text{refunding}}$	Sum of refunding PCBs issued during the indicated time period. Source: SDC Platinum.
Aggregate volume$_{\text{refunding}}$	Sum of refunding PCB issuance volume during the indicated time period. Source: SDC Platinum.
PCB dummy$_{\text{refunding}}$	Dummy which equals one if the firm issues a PCB refunding bond in the respective year. Source: SDC Platinum.
PCB volume$_{\text{refunding}}$	Firm-level issuance volume of refunding PCBs. Source: SDC Platinum.
Issue year	Year of the respective PCB bond issuance. Source: SDC Platinum.
State x Issue year FE	Year of the respective PCB bond issuance interacted with state fixed effects. Source: SDC Platinum, Compustat.
Post issuance	Dummy which equals one in the three years following the issuance of a PCB.
Conventional bond yield measures and control variables	
Conventional bond yield$_{\text{avg}}$	Annual or quarterly average of Moody's yield for Aaa-rated corporate bonds in percent. Source: Federal Reserve Bank of St. Louis.
Conventional BAA-rated bond yield$_{\text{avg}}$	Annual or quarterly average of Moody's yield for Baa-rated corporate bonds in percent. Source: Federal Reserve Bank of St. Louis.
Lag of GDP per cap	Quarterly real gross domestic product per capita, measured in chained 2012 dollars, lagged by one quarter. Source: Federal Reserve Bank of St. Louis.
Recession indicator$_{\text{q}}$	Dummy equal to one if the quarterly NBER-based recession indicator for the U.S. equals one. Source: Federal Reserve Bank of St. Louis.
Recession indicator$_{\text{y}}$	Dummy equal to one if the NBER-based recession indicator for the U.S. equals one in any of the respective year's quarters. Source: Federal Reserve Bank of St. Louis.
Calendar-quarter nr.	Numeric indicator for the respective calendar-year quarter.
Main firm characteristics	

Continued on next page

Appendix A continued

Variable	**Description**
Lag of Size	Natural logarithm of one plus total assets (item: at), lagged by one period. Source: Compustat.
Lag of RoA	Operating income before depreciation (item: oibdp) divided by total assets (item: at), lagged by one period. Source: Compustat.
Lag of Leverage	Long term debt (item: dltt) plus debt in current liabilities (item: dlc) divided by book value of common equity (item: ceq) plus long-term debt and debt in current liabilities, lagged by one period. Source: Compustat.
Sales growth	Difference between log(sales) in year t and log(sales) in year t-1 (sales refers to item: sale). Source: Compustat.
Size quintile	Size group number based on a firm's average size over the sample period from 1980 to 2013. Size quintile 1 captures the group of smallest firms, while quintile 5 captures the group of largest firms. Source: Compustat.
Size-by-industry quintile	Size group number by two-digit SIC code industry, based on a firm's average size over the sample period from 1980 to 2013. 1 refers to the smallest firms within a two-digit SIC industry, and 5 refers to the largest firms. Source: Compustat.
Additional firm characteristics	
Capex/Assets	Capex (item: capx) divided by the beginning of period total assets (item: at). Source: Compustat.
R&D/Assets$_{\text{imputed}}$	R&D expenses (item: xrd) divided by the beginning of period total assets (item: at). Missing values are set to zero. Source: Compustat.
R&D/Assets	R&D expenses (item: xrd) divided by the beginning of period total assets (item: at). Source: Compustat.
Log(Employment)	Natural logarithm of one plus the number of employees (item: emp). Source: Compustat.
Cash/Assets	Cash and short-term investments (item: che) divided by the beginning of period total assets (item: at). Source: Compustat.
PPE/Assets	Property, plant, and equipment (item: ppent) divided by the beginning of period total assets (item: at). Source: Compustat
Market-to-book	Total assets (item: at) minus book value of common equity (item: ceq) plus market value of common equity (items: prcc_f multiplied by csho), divided by total assets (item: at). Source: Compustat.
Payout ratio	Sum of dividends on preferred stock (item: dvp), dividends on common stock (item: dvc), and purchase of common and preferred stock (item: prstkc), divided by income before extraordinary items (item: ib). Source: Compustat.
Industry x Year FE	Two-digit SIC industry code interacted with year fixed effects. Source: Compustat.

B. Additional figures

Figure B.1
Inflation-adjusted issuance volume of pollution control bonds over time

This figure illustrates the volume of pollution control bonds issued over time, with the volume of issuance adjusted for inflation and expressed in 2013 USDb. I separately show the issuance of new money bonds (■) and refunding bonds (■) per calendar year.

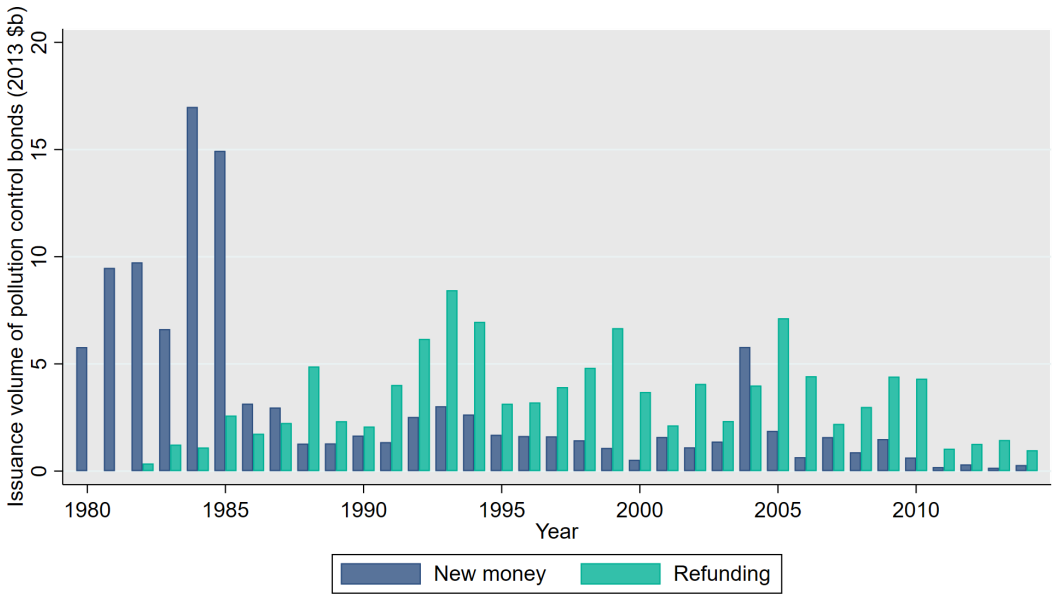
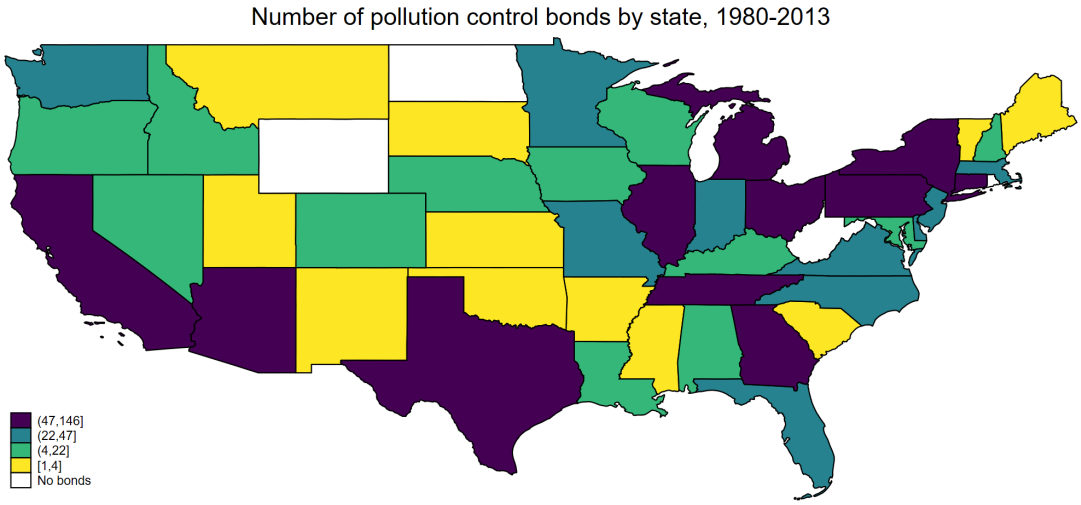


Figure B.2

Issuance of tax-subsidized pollution control bonds by state between 1980 and 2013

This figure illustrates the issuance of pollution control bonds by state, based on the location of the issuing firms' headquarters. The sample consists of new money PCBs issued by Compustat firms between 1980 and 2013. States marked in white have no PCB issues between 1980 and 2013. States marked in yellow (■) are in the bottom quartile in terms of total state-level PCB issuance. States marked in green (■) are in the second quartile regarding total PCB issuance. States marked in blue are in the third quartile (■), while states marked in violet (■) are in the top quartile of states in terms of total PCB issuance. Subfigure (a) shows the map for the total number of bonds by state. Subfigure (b) shows the map for the total issuance volume of bonds by state (adjusted for inflation and expressed in 2013 USDb).

(a) Number of pollution control bonds by state



(b) Issuance volume of pollution control bonds by state

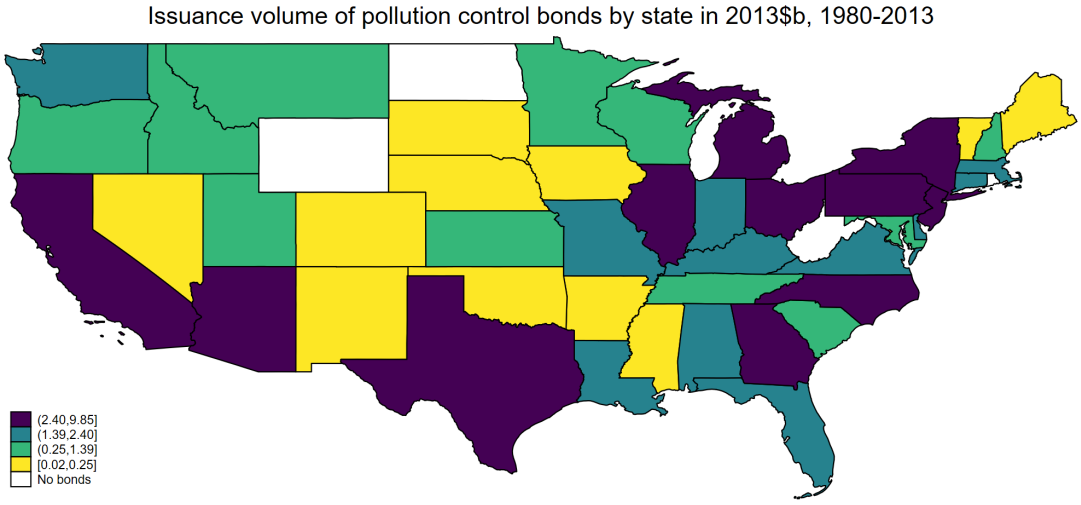


Figure B.3

Characteristics of pollution control bond issuers

This figure illustrates the unadjusted difference in means of firm characteristics between firms that issue a pollution control bond between 1980 and 2013, and firms covered by Compustat that do not. The bars mark the 90% confidence intervals. To measure differences in characteristics prior to issuance, all characteristic variables are measured in t-1. Appendix A provides a detailed description of all variables.

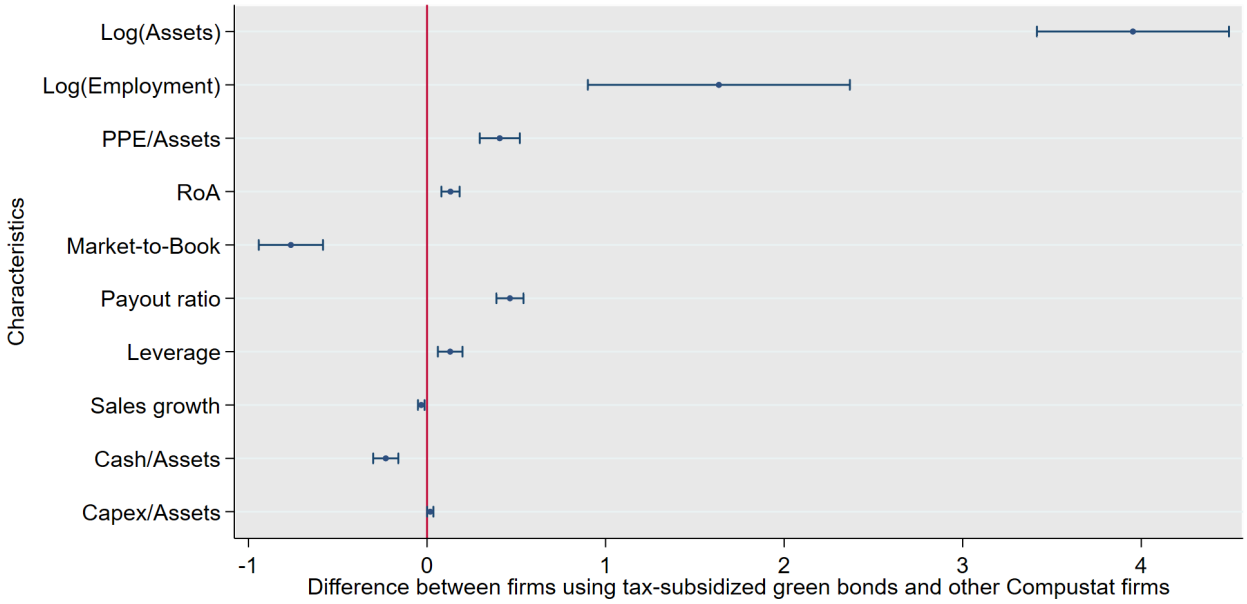


Figure B.4

Pollution control bond issuance and firms' sales growth: effect of issuance volume

This figure illustrates the development of sales growth for firms that issue a pollution control bond between 1980 and 1984, relative to a matched control group. It shows coefficient estimates and the 90% confidence interval on the logarithm of the PCB volume interacted with event-time dummies. The regression specification follows column (3) in Table 7. Sales growth is measured as the difference in log(sales) between year t and year t-1. Appendix A provides a detailed description of all variables.

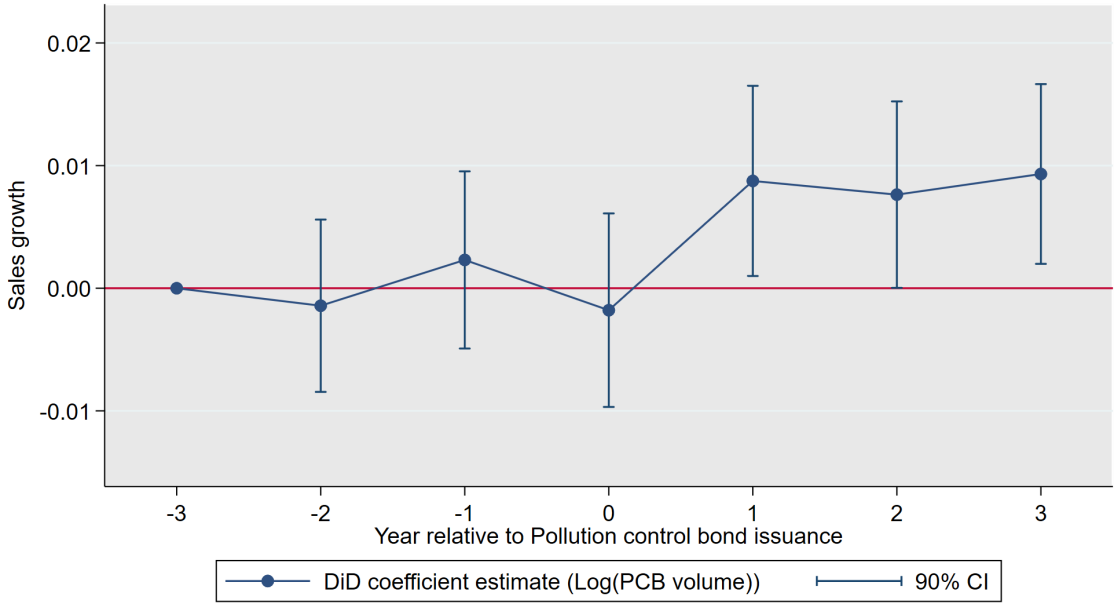
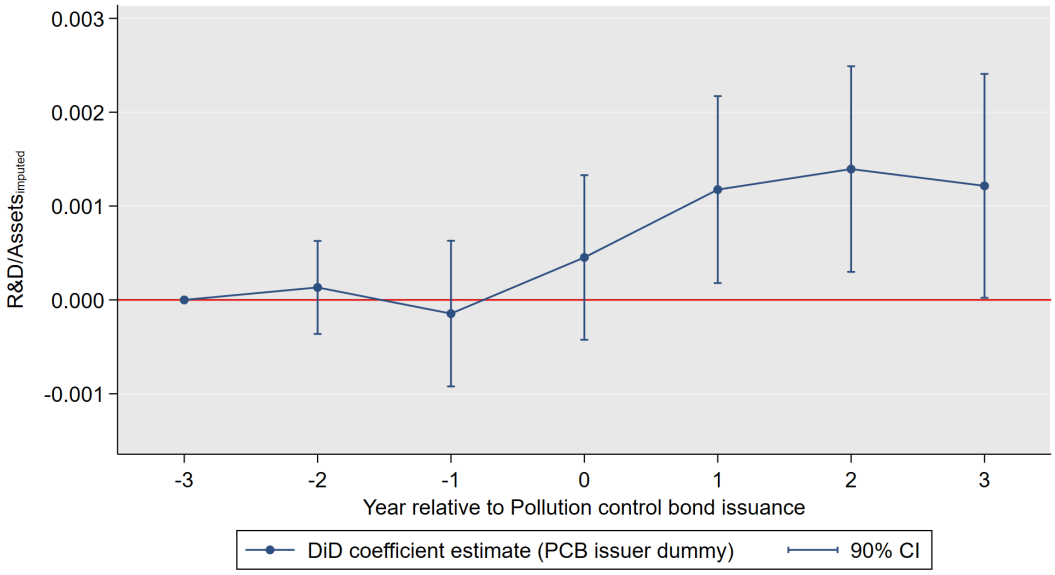


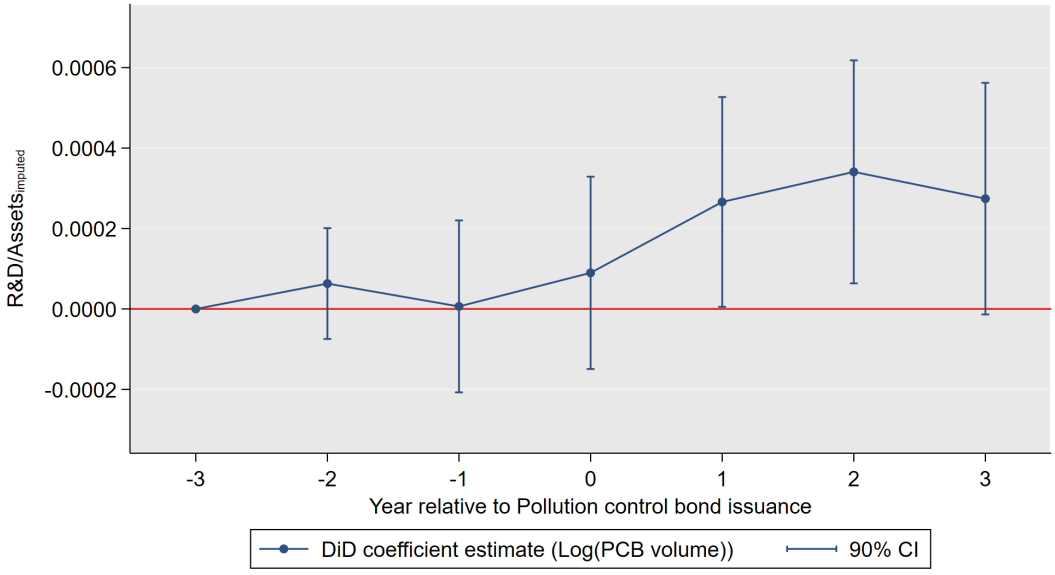
Figure B.5
Pollution control bond issuance and firms' R&D investment

This figure illustrates the development of R&D investment (zero-imputed) for firms that issue a pollution control bond between 1980 and 1984, relative to a matched control group of non-issuers. It shows coefficient estimates and the 90% confidence interval on the PCB issuance measure interacted with event-time dummies. In Subfigure (a), the PCB issuance measure is the PCB issuer dummy. In Subfigure (b), the PCB issuance measure is the logarithm of the PCB volume. The regression specification follows column (2) in Table 8. Sales growth is measured as the difference in log(sales) between year t and year t-1. Appendix A provides a detailed description of all variables.

(a) PCB issuer dummy and R&D investment



(b) PCB volume and R&D investment



C. Additional tables

Table C.1

Conventional Baa-rated bond yields and pollution control bond issuance

The table reports the results of regressing measures of pollution control bond issuance on the average quarterly conventional bond market yield for Moody's Baa-rated corporate bonds. All regressions are at the calendar-quarter level and follow the specification of equation 2. In Panel A, the dependent variables are the natural logarithm of the quarterly number of new money PCBs plus one (columns 1 and 2), and the natural logarithm of the quarterly total volume of new money PCBs plus one (columns 3 and 4), respectively. The sample period is from 1980 to 2013. Panel B uses the same measures of pollution control bond issuance for refunding bonds. For Panel B, the sample period is from 1983 to 2013. T-statistics based on Huber/White robust standard errors clustered by calendar-quarter number are presented in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	(1)	(2)	(3)	(4)
Panel A: Issuance of new money pollution control bond				
	Log(Bond number$_{\text{new}}$)		Log(Aggregate volume$_{\text{new}}$)	
Conventional BAA-rated bond yield$_{\text{q, avg}}$	0.112*	0.109**	0.207***	0.201**
	(3.127)	(4.042)	(9.055)	(5.676)
Calendar-quarter nr. FE	No	Yes	No	Yes
Lag of GDP per cap	Yes	Yes	Yes	Yes
Recession indicator	No	Yes	No	Yes
Number of observations	136	136	136	136
Adjusted R^2	0.412	0.525	0.390	0.411
Panel B: Issuance of refunding pollution control bonds				
	Log(Bond number$_{\text{ref}}$)		Log(Aggregate volume$_{\text{ref}}$)	
Conventional BAA-rated bond yield$_{\text{q, avg}}$	-0.277***	-0.350***	-0.243**	-0.319**
	(-7.466)	(-8.325)	(-4.912)	(-3.387)
Calendar-quarter nr. FE	No	Yes	No	Yes
Lag of GDP per cap	Yes	Yes	Yes	Yes
Recession indicator	No	Yes	No	Yes
Number of observations	124	124	124	124
Adjusted R^2	0.137	0.230	0.0346	0.122

Table C.2

Conventional bond yields and firm-level pollution control bond issuance: controlling for decade-specific trends

The table reports the results of regressing firm-level measures of pollution control bond issuance on the average annual conventional bond market yield, controlling for decade-specific time trends using decade fixed effects. The sample includes Compustat firms with at least one PCB issuance during the sample period from 1980 to 2013. Conventional bond yield is the quarterly average of Moody's yield for Aaa-rated corporate bonds in percent, obtained from the Federal Reserve Bank of St. Louis. In Panel A, the dependent variables are the dummy for PCB issuance (columns 1 and 2), and the natural logarithm of the annual new money PCB volume plus one (columns 3 and 4), respectively. Panel B uses the same firm-level measures of pollution control bond issuance for refunding bonds. For Panel B, the sample period is from 1983 to 2013. Firm controls include lag of size, lag of return on assets, and lag of leverage. For columns (2) and (4), I additionally control for state-by-decade and industry-by-decade specific trends. T-statistics based on Huber/White robust standard errors clustered by firm are presented in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	(1)	(2)	(3)	(4)
Panel A: Firm-level issuance of new money pollution control bonds				
	PCB $\text{dummy}_{\text{new money}}$		$\text{Log(PCB volume}_{\text{new money}}\text{)}$	
$\text{Conventional bond yield}_{\text{y,avg}}$	0.051***	0.050***	0.228***	0.223***
	(13.263)	(12.700)	(13.343)	(12.927)
Recession dummy	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Decade FE	Yes	No	Yes	No
State x Decade FE	No	Yes	No	Yes
Industry x Decade FE	No	Yes	No	Yes
Number of observations	7,849	7,824	7,849	7,824
Adjusted R^2	0.147	0.154	0.162	0.173
Panel B: Firm-level issuance of refunding pollution control bonds				
	$\text{PCB dummy}_{\text{refunding}}$		$\text{Log(PCB volume}_{\text{refunding}}\text{)}$	
$\text{Conventional bond yield}_{\text{y,avg}}$	-0.003	-0.003	-0.020	-0.020
	(-0.780)	(-0.850)	(-1.285)	(-1.268)
Recession dummy	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Decade FE	Yes	No	Yes	No
State x Decade FE	No	Yes	No	Yes
Industry x Decade FE	No	Yes	No	Yes
Number of observations	7,045	7,042	7,045	7,042
Adjusted R^2	0.0918	0.0894	0.102	0.0977

Table C.3

Matching of PCB issuers to other non-PCB issuing Compustat firms

This table presents the mean pre-period characteristics and differences in means for firms that issue a pollution control bond between 1980 and 1984, and a matched control group. All figures are calculated after the matching is conducted. The pre-period corresponds to the three years before the respective year of the PCB issue. The matching process is described in Section 5.1. In Panel A, the comparison is displayed for the main control group. Panel B captures an alternative control group that additionally requires exact matching based on size-by-industry quintile. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	PCB issuing firms		**Matched control firms**			
	N	Mean	N	Mean	Diff.	T-stat
Panel A: Issuers and main control group						
Variables used in the matching process						
Lag of Size	447	7.46	447	6.41	1.05***	(12.90)
Lag of RoA	447	0.14	447	0.14	-0.00	(-1.09)
Capex/Assets	447	0.12	447	0.11	0.02***	(5.06)
PPE/Assets	447	0.80	447	0.70	0.10***	(6.07)
Sales growth	447	0.14	447	0.13	0.00	(0.58)
Other variables						
Lag of Leverage	447	0.49	447	0.48	0.01	(0.94)
Log(Employment)	445	2.34	444	1.79	0.55***	(6.80)
Cash/Assets	447	0.04	447	0.04	-0.01	(-1.51)
Payout ratio	435	0.67	430	0.63	0.04	(1.25)
Market-to-book	388	1.03	400	1.07	-0.04*	(-1.80)
R&D/Assets, imputed	447	0.01	447	0.01	0.00	(0.58)
R&D/Assets	134	0.03	102	0.03	-0.01	(-1.50)
Panel B: Issuers and control group with additional matching on size-by-industry quintile						
Variables used in the matching process						
Lag of Size	282	7.49	282	7.01	0.48***	(-5.39)
Lag of RoA	282	0.14	282	0.14	0.00	(-0.69)
Capex/Assets	282	0.13	282	0.11	0.02***	(-4.22)
PPE/Assets	282	0.79	282	0.69	0.09***	(-4.20)
Sales growth	282	0.14	282	0.14	-0.01	(-0.82)
Other variables						
Lag of Leverage	282	0.48	282	0.48	0.01	(-0.48)
Log(Employment)	280	2.44	279	2.16	0.27***	(-2.67)
Cash/Assets	282	0.04	282	0.04	0.00	(-0.36)
Payout ratio	270	0.68	263	0.61	0.07**	(-2.06)
Market-to-book	243	1.04	260	1.08	-0.04	(-1.34)
R&D/Assets, imputed	282	0.01	282	0.01	0.00	(-0.37)
R&D/Assets	92	0.03	85	0.03	0.00	(-0.09)

Table C.4

Pollution control bond issuance and firms' sales growth: issue year between 1980 and 1982

The table reports the results of difference-in-differences regressions for the association between PCB issuance and sales growth. The sample consists of PCB issuers that tap the PCB market between 1980 and 1982, and their matched control firms, following the matching procedure described in Section 5.1. Other than that, the specification follows equation 3. Post issuance is a dummy that equals one in the three years following the firm's first PCB issuance. For Panel A, the treatment measure PCB issuer$_{80,81,82}$ is a dummy that equals one if the firm issues any new money PCB between 1980 and 1982. For Panel B, the treatment measure is the natural logarithm of the volume of the first new money PCB issuance between 1980 and 1982 plus one, and is zero for the matched control group. Firm controls are lag of size, lag of return on assets, and lag of leverage. The sample period is from three years before the PCB issuance to three years thereafter. T-statistics based on Huber/White robust standard errors clustered by firm are presented in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	(1)	(2)	(3)
	Sales growth		
Panel A: PCB issuer dummy			
PCB issuer$_{80,81,82}$ x Post issuance	0.016	0.023*	0.018*
	(1.443)	(1.944)	(1.905)
Firm controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Event time FE	Yes	Yes	Yes
Issue year FE	Yes	No	No
State x Issue year FE	No	Yes	Yes
Industry x Year FE	No	No	Yes
Number of observations	1,580	1,461	1,447
Adjusted R^2	0.213	0.176	0.408
Panel B: PCB volume			
Log(PCB volume$_{80,81,82}$) x Post issuance	0.007**	0.009***	0.007**
	(2.216)	(2.747)	(2.391)
Firm controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Event time FE	Yes	Yes	Yes
Issue year FE	Yes	No	No
State x Issue year FE	No	Yes	Yes
Industry x Year FE	No	No	Yes
Number of observations	1,580	1,461	1,447
Adjusted R^2	0.215	0.179	0.409

Table C.5

Pollution control bond issuance and firms' sales growth: other control group

The table reports the results of difference-in-differences regressions for the association between PCB issuance and sales growth. The control group for this table also requires exact matching based on size-by-industry quintile in addition to the control group characteristics described in Section 5.1. Other than that, the specification follows equation 3. The dependent variable sales growth is the difference in log(sales) between year t and year t-1. Post issuance is a dummy that equals one in the three years following the firm's first PCB issuance. In Panel A, the treatment measure PCB issuer$_{\text{new money}}$ is a dummy that equals one if the firm issues any PCB between 1980 and 1984. In Panel B, the treatment measure is the natural logarithm of the volume of the first PCB issuance between 1980 and 1984 plus one, and is zero for the matched control group. Firm controls are lag of size, lag of return on assets, and lag of leverage. The sample period is from three years before the PCB issuance to three years thereafter. T-statistics based on Huber/White robust standard errors clustered by firm are presented in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-levels, respectively. Appendix A provides a detailed description of all variables.

	(1)	(2)	(3)	(4)
	Sales growth			
Panel A: PCB issuer dummy				
PCB issuer$_{\text{new money}}$ x Post issuance	0.024*	0.030**	0.027**	0.029**
	(1.916)	(2.267)	(2.403)	(2.552)
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Event time FE	Yes	Yes	Yes	Yes
Issue year FE	Yes	No	No	No
State x Issue year FE	No	Yes	Yes	Yes
Industry x Year FE	No	No	Yes	Yes
Size-by-industry quintile x Year FE	No	No	No	Yes
Number of observations	1,306	1,188	1,172	1,170
Adjusted R^2	0.212	0.165	0.385	0.404
Panel B: PCB volume				
Log(PCB volume$_{\text{new money}}$) x Post issuance	0.009**	0.010***	0.009***	0.009***
	(2.498)	(2.738)	(3.021)	(3.087)
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Event time FE	Yes	Yes	Yes	Yes
Issue year FE	Yes	No	No	No
State x Issue year FE	No	Yes	Yes	Yes
Industry x Year FE	No	No	Yes	Yes
Size-by-industry quintile x Year FE	No	No	No	Yes
Number of observations	1,306	1,188	1,172	1,170
Adjusted R^2	0.214	0.167	0.387	0.405