# Corporate Finance and Environmental Policy: Evidence from China's Emissions Trading Scheme

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**Abstract**

This study investigates corporate financing responses to environmental policy by examining the impact of China's emissions trading scheme (ETS). Using a difference-in-differences method, we find evidence that the ETS incentivizes firms to expand their financial bases for innovation rather than operational activities. Interestingly, these effects are mainly observed among financially constrained, high-polluting firms. We investigate the underlying reasons for this heterogeneity, explore their sources of financing, and analyze the consequences of their financing responses. We find no systematic changes in bank loan or bond debt but observe a greater reliance on trade credit, a more conservative dividend policy, and increased tax avoidance. We observe productivity improvements but higher liquidity and default risks. Our study highlights notable distinctions in corporate financing responses across diverse environmental policies, reveals the active pursuit of alternative financial resources to support innovation efforts, and provides insights for policymakers driving the green transition.

**JEL Codes:** G32, O16, Q55

**Keywords:** Emissions Trading Scheme; Financial Structure; Porter Hypothesis.

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# 1 Introduction

In recent decades, climate change has gained widespread recognition, capturing the attention of academia, industry, policymakers, and the public (Stern, 2008; Allen et al., 2009; Heal, 2009; Howe et al., 2013). As a result, environmental policies have taken center stage in the fight against climate change (Stern, 2008; Fowlie, 2010). Notable examples include the Emissions Trading Scheme (ETS) in China and the European Union, as well as the Clean Air Act (CAA) in China and the United States. While policymakers, investors, and scholars acknowledge policy risk as the primary climate risk to businesses (Stroebel and Wurgler, 2021), there remains a significant knowledge gap concerning the corporate financing responses to these risks (Diaz-Rainey et al., 2017; Stroebel and Wurgler, 2021).

To fill the gap, a growing body of literature has emerged to explore the relationship between climate risk and financial structure (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023; Yip et al., 2024). This research consensus suggests that firms tend to decrease financial leverage in response to climate risk. The rationale is that climate risk increases operating leverage and the likelihood of financial distress (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023). Consequently, lenders charge higher interest rates to high-polluting firms, elevating their cost of debt (Chava, 2014; De Greiff et al., 2018; Herbohn et al., 2019; Fard et al., 2020; Huang et al., 2021; Dang et al., 2022). In response, firms, particularly those with tighter financial constraints, opt to reduce their financial leverage (Nguyen and Phan, 2020; Yip et al., 2024). Moreover, Yip et al. (2024) demonstrate that environmental policy adversely affects the productivity of financially constrained firms.

Most of these findings align with the compliance cost hypothesis, which posits that environmental policies impose additional costs on firms due to mandatory abatement activities (Jaffe et al., 1995). The environmental compliance cost can crowd out investments and hinder corporate productivity (Gray and Shadbegian, 2003). The observed increase in operating leverage and productivity loss support the compliance cost hypothesis (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023; Yip et al., 2024).

Meanwhile, the Porter Hypothesis presents a counter-argument, suggesting that environmental policies can stimulate innovation and enhance productivity (Porter, 1991; Porter and Van der Linde, 1995; Jaffe and Palmer, 1997). The literature indicates that innovation and productivity gains arise more likely from stringent and flexible policy instruments, such as market-based environmental policies (Porter, 1991; Jaffe and Palmer, 1997).[1] However, the literature on the relationship between climate risk and financial structure predominantly focuses on non-market-based environmental policies and climate physical risk (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023; Yip et al., 2024), leaving a significant gap in understanding the financial implications of market-based policies.

The primary objective of this paper is to investigate to what extent firms adapt their financial structure to a market-based environmental policy. Specifically, we examine whether the adaptation of financial structures to market-based policy and other climate risks are similar. Additionally, we explore the purpose, the source, and the consequence of financing. Do they adapt their financial structure for innovation or operational purposes? Does the adaptation operate through debt or non-interest-bearing liabilities? Does market-based policy enhance productivity but expose firms to higher liquidity and default risk? These questions are important because they address public concerns regarding the financial instability created by environmental policies (Huang et al., 2021; Stroebel and Wurgler, 2021).

These topics hold particular significance in developing economies. As economic growth leads to increased prosperity, it often accompanies severe pollution problems in these countries. While firm growth and pollution reduction require substantial financial resources (Guariglia et al., 2011; Fafchamps and Schündeln, 2013), accessing formal credit can be challenging in developing economies (Allen et al., 2005). Balancing economic growth with environmental protection poses a significant policy challenge. Therefore, understanding how firms adapt their financing policies to environmental policy in developing countries is crucial.

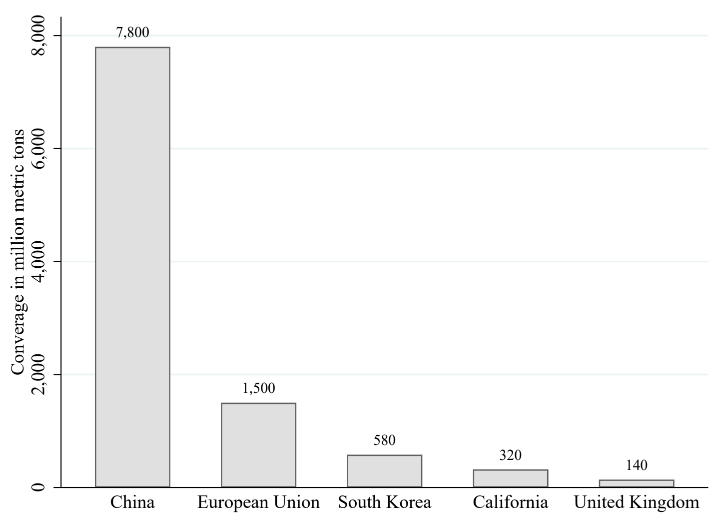
However, establishing a causal relationship between environmental policy and corporate financing decisions is empirically challenging. For example, environmental policy may increase the cost of debt and equity (Chava, 2014). Moreover, access to public equity markets may impact emissions (Shive and Forster, 2020). The relationship between corporate exposure to emissions and financing choices is susceptible to endogeneity con-

[1] Jaffe and Palmer (1997) further points out that "*almost all existing U.S. environmental regulations are not of this type*".

cerns.

To address the endogeneity issue, we take advantage of a unique opportunity provided by China's ETS, a market-based environmental policy. According to Figure 1, China has the largest operational emissions trading market, covering around 7,800 million metric tons of carbon dioxide equivalent emissions in 2022. This coverage exceeds the combined coverage of the emissions trading markets in the European Union, South Korea, California, and the United Kingdom. Our specific focus on China's ETS over the EU ETS is due to the timing of the 2008 financial crisis, which coincided with the first and second phases of the EU ETS. This crisis has the potential to impact corporate financial decisions (Ivashina and Scharfstein, 2010; Kahle and Stulz, 2013) and introduce biases that could contaminate the estimation results. China's ETS was initially introduced as a pilot program in 2013, with the aim of exploring and gradually establishing a nationwide carbon emissions trading market. By employing the difference-in-differences (DID) approach, we can estimate the causal effect of market-based environmental policy by comparing the financing responses between pilot and non-pilot regimes before and after the implementation of China's ETS.

Figure 1: Coverage of Largest Emissions Trading Schemes in 2022




Note: We obtain the data from the International Carbon Action Partnership.

Our econometric results unambiguously find that the ETS incentivizes firms to adopt a more aggressive financial structure. We set a high bar to refute our conclusion that environmental policy constitutes an essential consideration in corporate financing decisions. Our placebo tests suggest that the documented financing responses are unlikely driven by factors other than the ETS. By analyzing the dynamic effect of the ETS, we find that the financial structures of the treatment and control firms stay parallel for five consecutive years ex ante and the trend deviates immediately ex post, suggesting that China's ETS is likely the driving force behind the documented responses. Our conclusions are robust to alternative model specifications, measures of financial leverage, matching strategies, and clustering approaches to standard errors.

Our results suggest that firms tend to adapt their financial structure for innovation rather than operational purposes. We find that the ETS stimulates R&D investment and thus enhances productivity. Moreover, innovation and productivity gains are mainly found among firms that expanded their financial bases ex post. By contrast, we find no evidence of significant changes in sales, cost, net cash flow from operating activities, or operating leverage. Our findings support the Porter Hypothesis (Porter, 1991; Porter and Van der Linde, 1995; Jaffe and Palmer, 1997) rather than the compliance cost hypothesis (Jaffe et al., 1995), revealing the significant difference in the purposes of financing responses between market-based and non-market-based policies.

Surprisingly, the financing and investment responses are mainly found among financially constrained, high-polluting firms. Consistent with the literature (Campello et al., 2010; Dang et al., 2022), we find that financially constrained, high-polluting firms tended to be less productive than their unconstrained counterparts ex ante. A stringent environmental policy, such as the ETS, provides them with the most incentives to catch up with the latest technology. Due to their financial constraints, we find no systematic change in their bank loan or bond debt. Instead, they tend to increase their financial leverage through non-interest-bearing liability. Our evidence further indicates that they actively seek alternative financial resources to finance R&D expenditures: They increase their trade credit, adopt a more conservative dividend policy, and engage in more tax avoidance. Our findings provide evidence for the pecking order theory in the context of market-based environmental policy: Firms prefer internal financing to external debt financing to support their R&D expenditure (Myers, 1984; Myers and Majluf, 1984; Graham and Harvey, 2001; Fama and French, 2002; Leary and Roberts, 2010). Consequently, the ETS improves their productivity but exposes them to higher liquidity and default risks.

This paper contributes to a broad literature that examines the effects of environmental policy on firm decision-making. While environmental policies have been implemented worldwide for decades, policymakers, investors, and scholars have recognized policy risk as the primary type of climate risk that businesses face during the transition to a greener economy (Stroebel and Wurgler, 2021). Consequently, there is growing concern about how policies impact various aspects of business operations, such as productivity (Berman and Bui, 2001; Albrizio et al., 2017; Wang et al., 2018; He et al., 2020), employment (Greenstone, 2002; Ferris et al., 2014; Curtis, 2017; Liu et al., 2017; Yip, 2018; Liu et al., 2021; Yip, 2023), exports (Shi and Xu, 2018), innovation (Nesta et al., 2014; Popp, 2019), and foreign direct investment (Chung, 2014; Cai et al., 2016).

Specifically, there is a burgeoning literature investigating the linkage between climate risk and corporate financing decisions. For instance, several studies (Krueger et al., 2020; Bolton and Kacperczyk, 2021; Duan et al., 2021; Huynh and Xia, 2021; Ilhan et al., 2021) find that investors are concerned about the financial consequences associated with climate risks. These findings help to explain why the market value of high-polluting firms is lower (Griffin et al., 2017) and why lenders tend to charge higher interest rates to these firms (Chava, 2014; De Greiff et al., 2018; Herbohn et al., 2019; Fard et al., 2020; Huang et al., 2021). To mitigate reputational damage resulting from emissions, firms may engage in social activities to foster goodwill (Cooper et al., 2018). However, there is a paucity of literature on how firms adjust their financial leverage in response to environmental policy (Diaz-Rainey et al., 2017; Stroebel and Wurgler, 2021).

This paper makes a primary contribution to the growing literature that studies the relationship between climate risk and financial structure (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023; Wei et al., 2024; Yip et al., 2024). This literature focuses mainly on non-market-based environmental policy and climate physical risk. The study for financing responses to market-based policy is, however, scant. The unique focus on a market-based environmental policy distinguishes this paper from the literature.

Moreover, prior studies primarily focus on examining climate risk in developed countries (Nguyen and Phan, 2020; Dang et al., 2022). Despite China being the largest $CO_2$ emitter as of 2023, there is a lack of research on the leverage responses to China's environmental policy. To fill this gap, we contribute to the literature by documenting evidence on the financing responses to environmental policy in China, which is the world's largest developing country and manufacturing hub.

Previous work has shown that climate risk tends to amplify operating leverage, firms respond by adopting a more conservative financial structure, and thus corporate productivity declines (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023; Yip et al., 2024). These results are largely consistent with the compliance cost hypothesis. This paper contributes by revealing significant differences in the responses of financing, investing, and operating activities between market-based policy and other climate policies. For example, we find that the ETS tends to affect investing activities rather than operating activities, stimulating innovation and enhancing productivity. Firms tended to adopt a more aggressive financing policy to finance innovation efforts. Our findings suggest that the Porter Hypothesis rather than the compliance cost hypothesis holds for market-based policy (Porter, 1991; Porter and Van der Linde, 1995; Jaffe and Palmer, 1997).

Despite substantial work dedicated to testing the Porter Hypothesis over two decades (Berman and Bui, 2001; Calel and Dechezleprêtre, 2016; Wang et al., 2018; Ambec et al., 2020; Calel, 2020; Dang et al., 2022; Yamazaki, 2022), little is known about the interplay between financial and investment responses to environmental policy. A widespread notion in the literature is that financial resource slack supports innovation (Damanpour, 1991) and enhances productivity (Campello et al., 2010; Dang et al., 2022). This paper contributes by revealing a surprising result—market-based policy provides innovation incentives to financially constrained firms rather than their unconstrained counterparts. We further extend the literature by exploring the underlying reasons, the means of financing, and the economic and financial consequences of R&D investment.

Moreover, this study indicates that environmental policy constitutes an essential consideration in trade credit, dividend policy, and tax avoidance (Balachandran and Nguyen, 2018; Geng et al., 2021; Compagnie et al., 2023). Balachandran and Nguyen (2018) argues that climate risk amplifies earnings uncertainty and firms respond by adopting a more conservative dividend policy. Another strand of literature indicates that climate risk amplifies operating leverage and firms respond by engaging in more tax avoidance to increase cash flow (Geng et al., 2021; Compagnie et al., 2023). This paper extends the literature by providing evidence for an alternative corporate motive: market-based policy stimulates the innovation of financially constrained firms. Because these firms struggle to access external finance, they increase trade credit, adopt a more conservative dividend policy, and engage in more tax avoidance to finance the heightened R&D expenditure. Our findings are consistent with the notion that trade finance, retained earnings, and corporate tax can provide liquidity insurance when bank credit is scarce (Garcia-Appendini and Montoriol-Garriga, 2013).

The rest of this paper is organized as follows. In section 2, we provide an overview of the background and key aspects of China's ETS. In section 3, we present the data, empirical methodology, and summary statistics. In section 4, we examine the relationship between the ETS and financing responses. In section 5, we explore the underlying factors that drive financing responses by examining the policy effect on investing and operating activities. In section 6, we investigate the source of financing. In section 7, we explore the consequence of financing. We conclude in section 8.

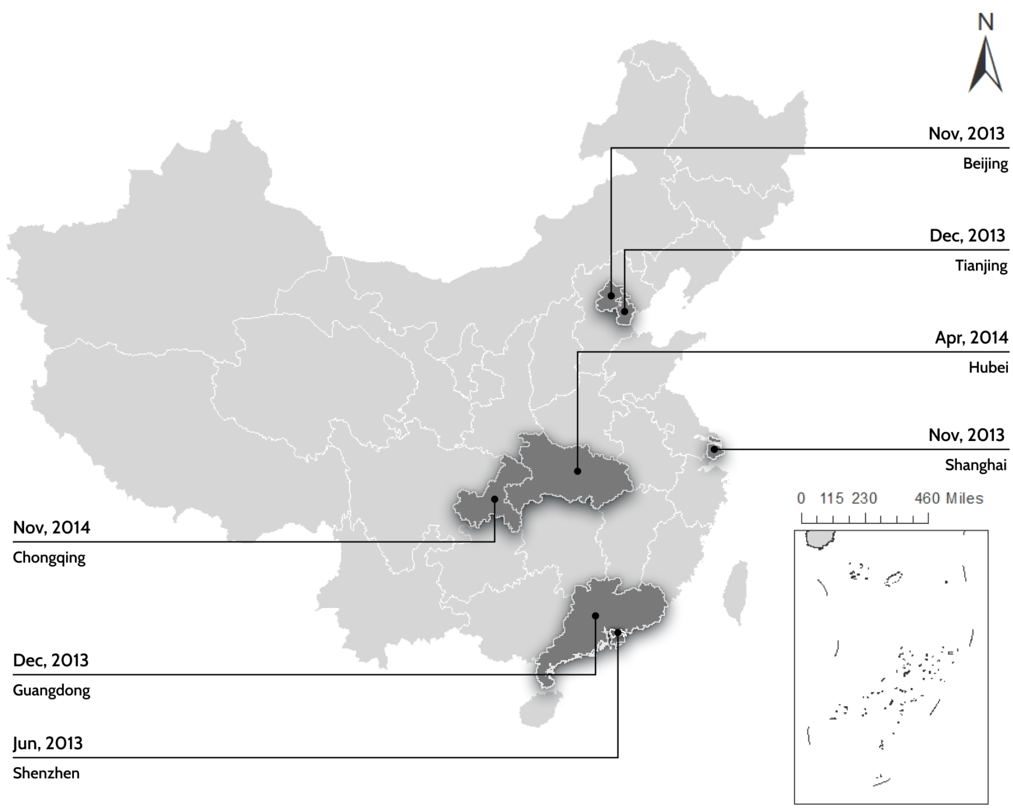
# 2 China's Emissions Trading System

Over the past three decades, China has experienced rapid economic growth and has emerged as a significant contributor to global $CO_2$ emissions. In its pursuit of both a transition to a green economy and sustained long-term economic development, the Chinese government has implemented a series of environmental measures. Initiated in the early 1980s, the preliminary phase of pollution control relied on command-and-control actions. These measures included energy-saving directives, more stringent emission reduction targets, and the issuance of operating licenses. However, the effectiveness of these policies is closely linked to the level of administrative efforts involved, which can result in substantial administrative costs.

As the economy continued to expand and industries upgraded, the subsequent phase marked a shift toward adopting market-based and incentive-driven approaches to environmental regulation. For example, pollution discharge fees have been increased three times to curb pollution emissions since their first implementation in 1982. However, $CO_2$ emissions have not effectively been mitigated because they were primarily designed to reduce pollution emissions. In 2009, China officially announced the clear and quantified goal of reducing greenhouse gas emissions for the first time. Specifically, by 2020, the target was to achieve a minimum 40% reduction in carbon emissions per unit of GDP compared to the levels in 2005.

To embrace a market-based approach and enhance the cost-effectiveness of $CO_2$ reduction, the National Development and Reform Commission (NDRC) of China introduced carbon trading pilot projects in 2011. These projects established $CO_2$ emissions trading markets in seven regimes, including Shenzhen, Shanghai, Beijing, Guangdong, Tianjin, Hubei, and Chongqing. Figure 2 illustrates the seven regimes. The ETS began in these selected regimes in 2013, marking the official start of carbon emission trading in China. More information on the launch date and the industries covered by the ETS can be found in Table A2 in the appendix.

Figure 2: The Pilot Regimes of China's ETS




Note: The dark areas indicate the pilot regimes of China's ETS.

China's ETS integrates a cap-and-trade mechanism with sector-specific coverage. A cap is set based on both sectoral and national scope. The aggregate volume of permissible emissions is established in alignment with the national $CO_2$ reduction target under a top-down command and control framework. Individual companies' emission allowances are calculated based on their historical emission level and their average industry carbon intensity. This framework establishes incentives for regulated companies to actively reduce carbon emissions and provides them with an opportunity to offset their emissions by engaging in trading within the market. More importantly, regulated companies should report their $CO_2$ emission before a specified deadline and allow a third party to verify their actual emission each year. The ETS covers a range of industries, with a predominant focus on manufacturing sectors, with several significant contributors such as power generation, iron and steel, cement, and chemicals industries.

The ETS pilot program provides an excellent opportunity to assess the causal effect of a market-based environmental policy on corporate financing decisions. First, the pilot program introduces a policy treatment that varies between pilot and non-pilot regimes. As only seven regimes were included in the ETS pilot programs, the industries covered by the ETS in the pilot regions can be regarded as the treatment group in our analysis, while the remaining industries serve as the control group. Second, the ETS offers a relatively clear demarcation between the pre- and post-policy periods. Most of the pilot programs were launched at the end of 2013, with a few starting in the first half of 2014. We anticipate observing the policy effect of the ETS from the end of 2014, providing a temporal variation before and after 2014. Our setting helps mitigate potential biases resulting from variations in the timing of policy implementation (Goodman-Bacon, 2021; Baker et al., 2022).

# 3 Identification Strategies

## 3.1 Identification Methods

This section discusses the identification methods to estimate the causal effect of China's ETS on corporate financing policies. Identification of the causal effects requires firms with similar characteristics to compare. Since firm characteristics such as financial structures can change over time, a simple comparison of firm characteristics between pre- and post-policy periods within the pilot regimes likely leads to biased estimates. Similarly, directly comparing pilot and non-pilot regimes at any given point in time may yield biased estimates because firm characteristics were different across Chinese regimes ex ante.

We exploit spatial and temporal variations in the ETS to solve the identification problem. First, we include a set of province-fixed effects to control for time-invariant, observed and unobserved, factors that account for the differences in the corporate performance between pilot and non-pilot regimes. Including the province-fixed effects ensures that estimates are derived from time-varying factors. Second, we introduce a set of time-fixed effects to control for time-varying factors that affect the Chinese economy at any given point in time, such as fluctuations in the exchange rate between Chinese yuan and US dollars.

The inclusion of these two sets of fixed effects allows us to identify the effects of the ETS by comparing the differences in corporate performance between pilot and non-pilot regimes and between the pre- and post-policy periods. This approach ensures that the estimates are free from biases arising from the time-invariant fundamental differences in firm characteristics between pilot and non-pilot regimes and from nationwide fluctuations in firm behaviors over time. This research design amounts to a standard DID regression estimator, with the treatment and control groups consisting of listed firms in the pilot and non-pilot regimes, respectively.

Using the DID approach, the causal effect of the ETS can be estimated by a regression model as follows:

$$Y_{ijpt} = \alpha + \beta(\mathit{ETS}_{jp} \times \mathit{Post}_t) + X^T_{ijpt-1}\gamma + \mu_i + \lambda_t + \epsilon_{ijpt}, \tag{1}$$

where $Y_{ijpt}$ is a financial outcome of firm *i* in industry *j* in province *p* in year *t*. For example, we estimate the policy effect on the leverage ratio. $\mathit{ETS}_{jp}$ equals one if a firm belongs to a pilot industry covered by the ETS, and zero otherwise. $\mathit{Post}_t$ equals one in the year 2014 and later, and zero otherwise. Following the literature (Frank and Goyal, 2009; Heider and Ljungqvist, 2015; Nguyen and Phan, 2020; Dang et al., 2022), we include a set of lagged firm characteristics $X_{it-1}$, including firm size measured by the logarithm of total assets (*Log(Assets)*), tangibility (*PP&E*), growth opportunities (*Market-to-Book*), and profitability (*EBIT*). We also control for firm-fixed effect $\mu_i$ and year-fixed effect $\lambda_t$, both of which are important determinants of financial structure (Lemmon et al., 2008; Cook and Tang, 2010). $\epsilon_{ijpt}$ is an error term that captures idiosyncratic changes in corporate performances over time. Detailed variable definitions can be found in Table A1 in the appendix.

$\hat{\beta}$ is the coefficient estimate of our interest. This key DID estimate captures the average treatment effect on the treated, providing the causal effect of the ETS on the financial structure. This estimation method assumes that treated and untreated firms would exhibit a parallel trend in financial leverage in the absence of ETS. We will discuss the validity of this assumption in detail in section 4.2.

The remaining issue is related to the estimation of standard errors. To carefully make a statistical inference, we estimate several cluster-robust standard errors. First, we follow the literature to estimate a robust standard error clustered at the firm level so that the financial outcome and the model error are allowed to be correlated over time within any given firm (Brandt et al., 2017; Defever et al., 2020; Fu et al., 2021). Second, we estimate a standard error clustered at the province level and report them in a curly bracket. Third, we estimate two-way cluster-robust standard errors (Cameron and Miller, 2015), employing clustering on two levels: province and industry. In this way, we allow the potential correlation between financial outcomes and model errors across industries within any specific province, while simultaneously accounting for possible correlations across provinces in any given industry. We report the two-way cluster-robust standard errors in curly brackets.

## 3.2 Data Descriptions

To test our hypothesis, we collect a sample of firms listed in the Chinese A-share market covered by the China Stock Market and Accounting Research Database (CSMAR). We use the CSMAR because it provides comprehensive information about financial statements and has become increasingly popular in prior studies to study the corporate performance and the stock market in China (Piotroski and Zhang, 2014; Liu et al., 2017; You et al., 2018; Li et al., 2021; Titman et al., 2022; Cai et al., 2023; Chen et al., 2023). We restrict our sample to 2009-2016 to avoid the financial crisis in 2008 and another pilot regime commenced at the end of 2016. Our initial sample contains 20,627 firm-year observations.

Following the literature, we trim our sample using the following criteria. First, we exclude firms in the financial industry because their financial statements are not comparable to those of nonfinancial firms. Second, we eliminate firms with missing information on variables in the main regression. Third, we remove firms that relocated their provincial address in the sample period to avoid any potential endogeneity problem from their relocation choices. Fourth, we delete observations with more debt than assets to minimize recording errors. Fifth, we remove observations from our sample if their audited net profits are negative for two consecutive fiscal years or the audited net assets per share in the most recent year are less than RMB¥1. The final sample includes 15,755 firm-year observations with 2,431 unique firms. We winsorize all variables at the 1st and 99th percentiles.

Table 1 presents the summary statistics of variables used in the main regression. About 16.6% of the firms come from the seven pilot regimes. On average, the liability constitutes 44.6% of assets at book value and 60.1% at market value. We present the summary statistics of other variables in Table A3 in the appendix.

Table 1: Descriptive Statistics

| **Variables** | **N** | **Mean** | **P25** | **Median** | **P75** | **Standard Deviation** |
|---|---|---|---|---|---|---|
| **Dependent Variables** | | | | | | |
| *Liability/BA* | 15,755 | 0.446 | 0.278 | 0.445 | 0.613 | 0.211 |
| *Liability/MA* | 15,755 | 0.601 | 0.14 | 0.324 | 0.737 | 0.751 |
| **Independent Variables** | | | | | | |
| *ETS* × *Post* | 15,755 | 0.072 | 0 | 0 | 0 | 0.259 |
| *ETS* | 15,755 | 0.166 | 0 | 0 | 0 | 0.372 |
| *Post* | 15,755 | 0.428 | 0 | 0 | 1 | 0.495 |
| **Control Variables** | | | | | | |
| *Log(Assets)* | 15,755 | 21.904 | 20.988 | 21.733 | 22.615 | 1.25 |
| *PP&E* | 15,755 | 0.232 | 0.099 | 0.196 | 0.333 | 0.17 |
| *Market-to-Book* | 15,755 | 1.505 | 0.579 | 1.02 | 1.857 | 1.473 |
| *EBIT* | 15,755 | 0.06 | 0.031 | 0.054 | 0.084 | 0.052 |
| *Advertising* | 15,755 | 0.039 | 0.009 | 0.022 | 0.046 | 0.05 |
| *Log(Employees)* | 15,731 | 7.567 | 6.731 | 7.523 | 8.374 | 1.304 |
| *Depreciation* | 15,710 | 0.021 | 0.009 | 0.017 | 0.029 | 0.015 |

Note: This table reports summary statistics. Table A1 presents variable definitions.

# 4 ETS and Financing Decisions

## 4.1 Basic Results

This section explores the relationship between the ETS and corporate financing decisions. Specifically, we estimate the effect on the leverage ratio from equation (1). We begin our analysis with a broad definition of the leverage ratio, which is measured by the ratios of total liabilities to total assets at book value *Liability/BA* and market value *Liability/MA*.[2] Table 2 presents the regression results. The dependent variables are *Liability/BA* and *Liability/MA* in columns (1)-(3) and (4)-(6). All columns include firm and year-fixed effects. Columns (2)-(3) and (5)-(6) control for firm characteristics that are quite standard in the corporate finance literature (Rajan and Zingales, 1995; Leary and Roberts, 2014; Graham et al., 2015; Simintzi et al., 2015; Nguyen and Phan, 2020; Dang et al., 2022). In addition, columns (3) and (6) follow the literature to include additional firm control variables for robustness tests (Wald and Long, 2007). Robust standard errors clustered at the levels of firms and provinces are reported in round and square brackets. We also report two-way cluster-robust standard errors across provinces and industries in curly brackets.

The results suggest that firms tend to expand their financial bases after the ETS. In columns (1) and (4), the estimates are positive and statistically significant at the five percent level. When we control for firm characteristics in columns (2) and (3), the estimates are significant at the one percent level. In our main models (columns (2) and (4)), the estimates suggest that firms, on average, increase *Liability/BA* and *Liability/MA* by 1.7 and 6.0 percentage points ex-post. Compared to the average *Liability/BA* and *Liability/MA* of 44.6 and 60.1 percentage points, the changes represent an increase of 3.81 and 9.98 percent, respectively. Our conclusion remains intact regardless of the ways we cluster standard errors.

## 4.2 The Dynamics of the Financing Responses

This section studies the dynamics of the leverage responses to the ETS. This exercise serves as an internal validity check on the results above. If the differences in the leverage

[2] The discussion on various definitions of the leverage ratio can be found in the literature (Rajan and Zingales, 1995; Welch, 2011; Keefe and Yaghoubi, 2016).

Table 2: The Effect of the ETS on Financial Leverage

| | *Liability/BA* | | | *Liability/MA* | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS × Post* | 0.016 | 0.017 | 0.017 | 0.057 | 0.060 | 0.60 |
| | (0.021)** | (0.008)*** | (0.008)*** | (0.033)** | (0.016)** | (0.016)** |
| | [0.029]** | [0.003]*** | [0.003]*** | [0.008]*** | [0.000]*** | [0.000]*** |
| | {0.000}*** | {0.000}*** | {0.000}*** | {0.027}** | {0.000}*** | {0.001}*** |
| *Log(Assets)* | | 0.067*** | 0.062*** | | 0.288*** | 0.296*** |
| | | (0.000) | (0.000) | | (0.000) | (0.000) |
| *PP&E* | | 0.099*** | 0.101*** | | -0.058 | 0.102 |
| | | (0.000) | (0.000) | | (0.339) | (0.198) |
| *Market-to-Book* | | 0.008*** | 0.008*** | | 0.007* | 0.008** |
| | | (0.000) | (0.000) | | (0.068) | (0.049) |
| *EBIT* | | -0.420*** | -0.428*** | | -0.921*** | -0.953*** |
| | | (0.000) | (0.000) | | (0.000) | (0.000) |
| *Advertising* | | | 0.143* | | | 0.364* |
| | | | (0.081) | | | (0.054) |
| *Log(Employees)* | | | 0.009** | | | -0.023 |
| | | | (0.012) | | | (0.117) |
| *Depreciation* | | | -0.227 | | | -2.796*** |
| | | | (0.384) | | | (0.003) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,755 | 15,755 | 15,710 | 15,755 | 15,755 | 15,710 |
| Adjusted $R^2$ | 0.809 | 0.825 | 0.825 | 0.731 | 0.748 | 0.749 |

Note: The average *Liability/BA* and *Liability/MA* are 44.6 and 60.1 percentage points. Standard errors are clustered at the levels of firm and province in round and square brackets. Two-way cluster-robust standard errors across provinces and industries are reported in curly brackets. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

ratio between treated and untreated firms happened to fluctuate in the pre-policy period, it is reasonable to argue that the documented financing responses likely arise from factors other than the ETS. If the differences stay constant ex-ante, they likely stay the same immediately following the policy. In other words, this analysis provides important information on the validity of the parallel trend assumption. If the documented financing response is driven by the ETS, we expect the effect to appear immediately following the implementation of the ETS. This analysis also provides another support for the source of the documented financing responses.

To estimate the dynamic effects, equation (1) is extended by replacing $ETS_{jp} \times Post_t$ with a full set of $ETS_{jp} \times Year_t$ interaction terms as follows:

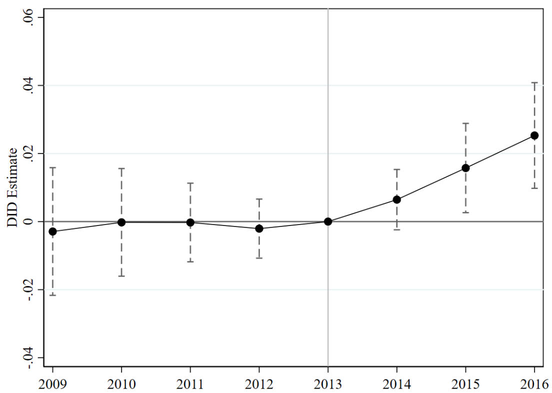
$$Y_{ijpt} = \alpha + \sum_{t \neq 2013} \beta_t \big(ETS_{jp} \times Year_t\big) + X^T_{ijpt-1}\gamma + \mu_i + \lambda_t + \epsilon_{ijpt}, \tag{2}$$

where $Year_t$ is a dummy variable for year and $t = \{2009, 2010, 2011, 2012, 2014, 2015, 2016\}$. While the ETS began in 2014, we use the year 2013 as the reference year. The inclusion of a constant term and the set of fixed effects normalizes the difference in the leverage ratio to be zero in the reference year. Figure 3 presents the regression estimates. The dependent variables are *Liability/BA* and *Liability/MA* in Panels A and B. Robust-standard errors are clustered at the firm level. The vertical dashed line represents the reference year. The vertical solid line represents a 95 percent confidence interval.

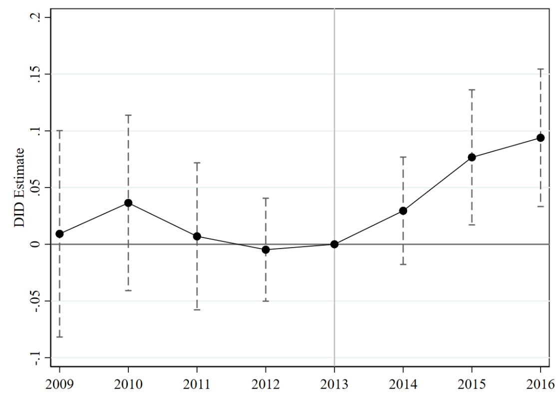
Our results strengthen the validity of the identifying assumption. In Panels A and B, all the estimates to the left of the dashed line are statistically insignificant at any conventional level, suggesting that the differences in the leverage ratio between treated and untreated firms are close for five consecutive years in the absence of the ETS ex ante. Therefore, if the ETS had not been implemented in 2014, the parallel trend in their leverage ratios would have likely been unaffected. That is, the estimated coefficient $\hat{\beta}_t$ would stay close to zero immediately following the ETS. However, the estimate increases significantly after the implementation of the ETS and the estimates continue to grow. In 2015 and 2016, the estimates are significant for all conventional levels. The results reveal that the parallel trend assumption is likely satisfied and the ETS is likely the driving force of the documented financing responses in section 4.1.

Table 3: The Dynamics of the Financing Responses

**Panel A: *Liability/BA***




**Panel B: *Liability/MA***




Note: The dependent variables are *Liability/BA* and *Liability/MA* in Panels A and B. Standard errors are clustered at the firm level in parentheses. The vertical grey line represents the reference year. The vertical dashed line represents a 95 percent confidence interval.

## 4.3 Robustness Tests

### 4.3.1 Covariate Balance Between the Treated and Untreated Samples

Systematic differences in the characteristics of the treated and untreated firms may drive the differences in their financial structures. To alleviate the concern, we follow Nguyen and Phan (2020) and Dang et al. (2022) and adopt two popular matching methods, namely propensity score matching (PSM) and entropy balancing (EB), to identify our untreated samples. To begin with, we estimate the propensity score of being a treated firm. We regress the treatment indicator $ETS_{jp}$ on relevant covariates including *Log(Assets)*, *Tangibility*, *Growth*, and *Profitability*. We match treated firms with the untreated ones using a one-to-one nearest neighbor matching within a caliper distance of 0.001 without replacement. Our matching process yields a sample of 2,619 pairs of treated and untreated firms. In Panel A of Table OA1, we compare the means of the propensity scores and covariates between the two groups of firms in our matched sample. We find no significant differences in the characteristics between these firms, suggesting that the covariate balance condition is likely satisfied. In columns (1) and (4) of Table 4, we estimate our DID model for the propensity score matched sample. Consistent with the baseline results, all the estimates are positive and significant at the one percent level, suggesting that firms expand their financial bases ex post.

Table 4: The Effects of the ETS Estimated using Three Matching Methods

| | *Liability/BA* | | | *Liability/MA* | | |
|---|---|---|---|---|---|---|
| | PSM | EB | CEM | PSM | EB | CEM |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.031*** | 0.017*** | 0.021** | 0.131*** | 0.076*** | 0.083** |
| | (0.000) | (0.009) | (0.016) | (0.000) | (0.004) | (0.014) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 5,238 | 15,755 | 5,084 | 5,238 | 15,755 | 5,084 |
| Adjusted $R^2$ | 0.833 | 0.835 | 0.882 | 0.772 | 0.776 | 0.823 |

Note: Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

To achieve balances on the higher moments of the covariates and to allow for nonlinear relations, we use EB in a multivariate matching approach (Hainmueller, 2012; King and Nielsen, 2019). We first match treated firms to untreated firms and assign weights to the untreated firms based on the first two moments (i.e., the mean and variance) of the firm-level covariates. We demonstrate the comparison of the first two moments of the firm characteristics between the treated and untreated firms in Panel B of Table OA1. The results suggest that an entropy balance has been achieved. We estimate the DID model using the EB sample and report the estimate in columns (2) and (5) of Table 4. We consistently observe positive and significant effects of the ETS on the leverage ratio, in line with our baseline results. We conduct similar analyses using EB based on the first and the first three moments of the firm-level covariates and our conclusion is quantitatively unchanged.[3]

In addition to two commonly used matching approaches, we also use the coarsened exact matching (CEM) method to identify the untreated sample because this matching method dominates commonly used matching methods, including propensity score and Mahalanobis matching, by reducing the imbalance, model dependence, estimation error, bias, variance, etc. (Iacus et al., 2011, 2012). The CEM method generates cells by dividing relevant continuous variables (i.e., *Log(Assets)*, *Tangibility*, *Growth*, and *Profitability*) into discrete intervals. If there does not exist any sample in either the treated or untreated group in a particular cell, all the observations in this cell are trimmed. The CEM algo-

[3]The results are presented in Table OA2 in the online appendix.

rithm returns the weight equal to one to each treated firm in the remaining cells and returns weights $n_t^j/n_c^j \times N_c/N_t$ to the untreated firms in each of the remaining cells $j$, where $n_t^j$ and $n_c^j$ are the sample sizes of treated and the untreated group in cell $j$. $N_t$ and $N_c$ are the total numbers of treated and untreated firms in the matched samples, respectively. These weights are used to rescale the weight of each observation in the matched untreated sample to balance the empirical distributions of the matching covariates between treated and untreated samples in the DID regression model. We use weighted ordinary least squares to estimate the effect of the ETS on the two leverage ratios from equation (1), where the weight is obtained from the CEM method. Panel C of Table OA1 compares the means of covariates between the two groups of firms in the matched sample and finds no significant differences in their characteristics. We report the estimate in columns (3) and (6) of Table 4. All the estimates suggest that the ETS incentivizes firms to expand their financial bases, in line with our baseline results.

Overall, we can conclude that our main finding holds after considering covariate balance and is robust to three popular matching methods.

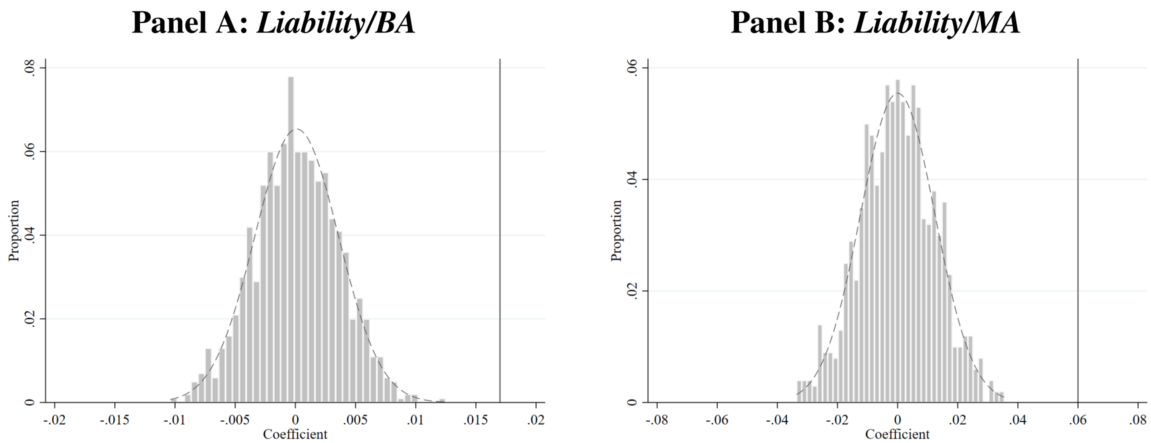
#### 4.3.2 Placebo Tests

We conduct placebo tests to examine the extent to which the documented effects result from any omitted variables. Since treated firms constitute about 16% of the sample, we randomly assign treatment to 16% of firms in our sample in 2013. We redefine ETS$_{jp}$: it equals one if a firm is randomly assigned treatment in 2013; and zero otherwise.

We use this random treatment to estimate the treatment effects on the *Liability/BA* and *Liability/MA* from equation (1). Given the random feature, the assigned treatment should yield an estimate with a magnitude close to zero. Otherwise, it is reasonable to assume that the documented financing responses are driven by factors other than the ETS. To increase the identification power of the test, we repeat the placebo test 1,000 times. Figure 5 presents the distribution of the estimates in the placebo tests. The dependent variables are *Liability/BA* and *Liability/MA* in Panels A and B. The vertical solid line presents the DID estimate using the true assignment of treatment.

The placebo tests strongly suggest that the ETS drives the documented financing responses. In each figure, the estimates from the random assignment of treatment are distributed around zero, reflecting the insignificant effects of the random treatment on the

Table 5: The Distribution of the Estimated Coefficients of the Placebo Tests




Note: The figures show the distribution density of the estimated coefficients of the placebo tests from 1,000 simulations. The dependent variables are *Liability/BA* and *Liability/MA* in Panels A and B. The vertical lines illustrate the estimated coefficient using the true assignment of the ETS.

two leverage ratios. By contrast, the estimate from the true assignment of the ETS is located outside the entire distribution in the two figures. That is, all the 1,000 placebo coefficients are a lot smaller than the estimated treatment effect. The results reveal that it is unlikely to find a random assignment of treatment that can produce an estimate similar to the one with the true assignment. In other words, the documented financing responses are unlikely driven by factors other than the ETS.

#### 4.3.3 Alternative Measures

Next, we consider alternative measures of the financial structure: the ratio of total liabilities to total equity at book value (*Liability/BE*) and the ratio of total liabilities to total equity at market value (*Liability/ME*). According to the summary statistics in Tables 1 and A3, the measures of the four leverage ratios are quite different. We conduct a battery of robustness tests with two additional measures of the financial structure.

First, we use *Liability/BE* and *Liability/ME* as dependent variables to repeat the analysis in section 4.1. The results in Table OA3 suggest that the two leverage ratios increase in the post-policy period. Second, we estimate the dynamic effects of the ETS on the two measures as in section 4.2. In Figure OA1, the estimates suggest that treated and untreated firms share parallel trends in the two ratios in the pre-policy period and the two ratios of treated firms increase sharply immediately following the ETS. The results strengthen the credibility of the parallel trend assumption and suggest that the ETS is the driving force of the documented financing responses. Third, we estimate the effect of the ETS on *Liability/BE* and *Liability/ME* using the three matching methods like section 4.3.1. Our result in Table OA4 is robust to three popular matching methods. Fourth, we conduct placebo tests similar to section 4.3.2 to examine the extent to which the documented effects on *Liability/BE* and *Liability/ME* result from any omitted variables. The results in Figure OA2 suggest that the documented financing responses are unlikely driven by factors other than the ETS.

Therefore, it can be confidently concluded that the ETS motivates firms to expand their financial bases. This conclusion remains strong even when considering various metrics for assessing the financial structure.

#### 4.3.4 Confounding Factor: China's Clean Air Act

In 2014, China implemented the Clean Air Act (CAA) with the objective of reducing air pollution, specifically targeting PM10 and PM2.5 pollutants. The central government established emission reduction targets for each province, which can be found in Table OA6 in the online appendix.

To address concerns that the observed changes in financial structure may be driven by the CAA rather than the ETS, we estimate the policy effect of the ETS while controlling for the CAA. In equation (1), we incorporate the variable $CAA \times Post$, where $CAA$ represents the natural logarithm of the reduction target under the CAA. By including this control variable, we aim to alleviate any doubts regarding the influence of the CAA on our findings.

We examine the dependent variables *Liability/BA*, *Liability/MA*, *Liability/BE*, and *Liability/ME* in our analysis. By doing so, we can assess the impact of the ETS on corporate financing decisions, while accounting for the potential influence of the CAA. Importantly, our analysis demonstrates that our conclusions remain qualitatively robust, even after considering the effects of the CAA. Detailed results can be found in Tables OA7 and OA8.

By conducting this additional analysis, we address concerns about the potential confounding effects of the CAA on our observed financing responses. This provides further support for the impact of the ETS on corporate financing decisions.

## 4.4 Heterogeneity in the Leverage Adjustments

Next, we explore which characteristics drive the financing responses. Certainly, the exploration provides an opportunity to explore the distributional effects, enhancing our understanding of the channels through which the effect of the ETS operates. This exercise also serves as an internal validity check on our key findings. If the documented fiancing responses are driven by the ETS, we expect the effect to share features similar to the effects of other environmental policies in China.

For example, the effects of climate risk are typically more pronounced among high-polluting firms (Chava, 2014; Balachandran and Nguyen, 2018; Wang et al., 2018; Herbohn et al., 2019; Nguyen and Phan, 2020; Huang et al., 2021; Yip et al., 2024). Moreover, the literature finds that the impacts of environmental policies on financial decisions are concentrated on financially constrained firms (Nguyen and Phan, 2020; Geng et al., 2021; Dang et al., 2022; Yip et al., 2024). Furthermore, in China, the policy effects are often found in non-state-owned enterprises (non-SOEs) partly because environmental policies are believed to be weakly enforced among SOEs in China (Cai et al., 2016; Liu et al., 2017; Chen et al., 2018; Wang et al., 2018; Geng et al., 2021; Ivanov et al., 2023; Mao et al., 2023; Wei et al., 2024; Yip et al., 2024). We, therefore, expect the effect of the ETS to be concentrated on non-SOEs.

### 4.4.1 Corporate Environmental Performances and Financing Responses

To begin with, we estimate the financing responses by environmental performance. We identify high-polluting firms by the corporate environmental responsibility score (ERS). We obtain the score from the corporate social reports (CSR) prepared by a financial news platform, known as HEXUN. Their CSR reports are widely used in the literature to evaluate the performance of publicly listed firms (Wang et al., 2019; Wen et al., 2020; Chen et al., 2022; Li and Guo, 2022). The ERS captures corporate environmental performances (Gillan et al., 2021). It ranges from zero to five. The higher the score, the better the corporate environmental performance. Since over half the samples received zero scores in 2013 (i.e., one year before the implementation of the ETS), we classify firms with positive ERS in 2013 as low-polluting firms, and the rest are high-polluting firms.

We estimate the effects of the ETS from equation (1) using the samples of high-polluting and low-polluting firms. We use *Liability/BA* as the dependent variable because stock price fluctuation could also affect the market value (Welch, 2004) and managers typically depend on book leverage to make corporate financing decisions (Graham, 2003; Serfling, 2016). For space considerations, we only report the results from the *Liability/BA* analysis.[4] Table 6 reports regression results. In columns (1)-(3) and (4)-(6), we restrict the sample to high-polluting and low-polluting firms. All models control for firm and year-fixed effects. We include firm characteristics that are quite standard in the corporate finance literature in columns (2), (3), (5), and (6). In addition, columns (3) and (6) follow the literature to include additional firm control variables for robustness tests (Wald and Long, 2007).

Our findings suggest that the effect of ETS varies significantly with corporate environmental performances. According to columns (1) to (3), the estimates are positive and significant for all conventional levels, suggesting that high-polluting firms tend to expand their financial bases ex post. In particular, the estimate in our baseline model suggests that the leverage ratio of high-polluting firms, on average, increases by 2.6 percentage points. By contrast, the estimates in columns (4) to (6) are an order of magnitude smaller and statistically insignificant at any conventional level, providing no support for any financing responses to the ETS among low-polluting firms. The heterogeneity is consistent with the literature on environmental economics and climate finance (Chava, 2014; Wang et al., 2018; Herbohn et al., 2019; Nguyen and Phan, 2020; Huang et al., 2021; Yip et al., 2024).

#### 4.4.2 Financial Constraints and Financing Responses

Panels A and B of Table 7 report the results from financially constrained and unconstrained firms, respectively. In column (1), we classify constrained and unconstrained firms using our composite measure. Columns (2)–(6) classify the two types of firms based on five alternative measures of financial constraints. These measures include the WW index, payout, firm size, SA index, and KZ index. Our result is qualitatively robust across all of these measures yielding economically meaningful estimates, a majority of which are statistically significant. The results provide strong and consistent evidence that the ETS increases the financial leverage of financially constrained firms. By contrast, the estimates in Panel B are smaller and are statistically insignificant, providing no support

[4] All conclusions are essentially the same if *Liability/MA* is used as the dependent variable.

Table 6: Environmental Performances and Financing Responses to the ETS

Dependent Variable: *Liability/BA*

| | High-Polluting Firms | | | Low-Polluting Firms | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.029*** | 0.026*** | 0.026*** | -0.006 | 0.002 | 0.002 |
| | (0.001) | (0.002) | (0.001) | (0.543) | (0.829) | (0.825) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variables (Baseline) | | Yes | Yes | | Yes | Yes |
| Additional Control Variables | | | Yes | | | Yes |
| Observations | 11,484 | 11,484 | 11,450 | 4,238 | 4,238 | 4,227 |
| Adjusted $R^2$ | 0.794 | 0.810 | 0.811 | 0.841 | 0.855 | 0.856 |

Note: The *Liability/BA* of high-polluting and low-polluting firms are 42.7% and 49.6%. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

for any financing responses to the ETS among unconstrained firms.

In summary, our results provide robust evidence that the financing responses operate almost exclusively among financially constrained firms. These findings are in line with the financial implication of climate risk (Nguyen and Phan, 2020; Geng et al., 2021; Dang et al., 2022; Yip et al., 2024).

#### 4.4.3 Ownership Structures and Financing Responses

In the following analysis, we investigate the relationship between ownership structures and the financing responses to the ETS. We estimate the financing responses by ownership structures using equation (1), and the key estimates are presented in Table 8. Specifically, columns (1)-(3) and (4)-(6) report the regression results from the sample of non-SOEs and SOEs, respectively. Firm and year-fixed effects are controlled for in all models. Baseline models are presented in columns (2) and (5), while columns (3) and (6) incorporate additional firm characteristics.

Our results indicate significant differences in the financing responses to the ETS between SOEs and non-SOEs. In columns (1) to (3), we observe a positive and significant effect of the ETS on the leverage ratio of non-SOEs. According to our baseline model, non-SOEs, on average, experience an increase of 3.2 percentage points in the *Liability/BA* ratio ex post. In contrast, the estimates in columns (4) to (6) are notably smaller in magni-

Table 7: Financial Constraints and Financing Responses to the ETS

Panel A: Financially Constrained Firms

| | Composite | WW | Payout | Size | HP | KZ |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.023** | 0.026** | 0.024** | 0.027*** | 0.016* | 0.014 |
| | (0.027) | (0.016) | (0.034) | (0.007) | (0.052) | (0.148) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 7,499 | 7,298 | 7,817 | 7,264 | 7,244 | 8,071 |
| Adjusted $R^2$ | 0.786 | 0.760 | 0.776 | 0.723 | 0.826 | 0.717 |

Panel B: Financially Unconstrained Firms

| | Composite | WW | Payout | Size | HP | KZ |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.011 | 0.011 | 0.005 | 0.008 | 0.012 | 0.010 |
| | (0.133) | (0.158) | (0.447) | (0.294) | (0.220) | (0.206) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 8,803 | 8,284 | 7,765 | 8,318 | 8,338 | 7,511 |
| Adjusted $R^2$ | 0.861 | 0.856 | 0.851 | 0.833 | 0.810 | 0.769 |

Note: Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

tude and statistically insignificant at conventional levels, providing no statistical evidence of financing responses among SOEs. Considering the large number of observations in our study, the lack of significance is unlikely due to low statistical power. Therefore, we can conclude that the financing responses are exclusive to non-SOEs, which is consistent with the literature on policy effects in China (Cai et al., 2016; Liu et al., 2017; Chen et al., 2018; Wang et al., 2018; Geng et al., 2021; Mao et al., 2023; Wei et al., 2024; Yip et al., 2024).

Overall, our findings suggest that the financing responses to environmental policy, such as the ETS, depend heavily on corporate environmental performances, financial constraints, and ownership structures. These responses can only be found among high-polluting firms, financially constrained firms, and non-SOEs. In contrast, the effects are almost negligible among low-polluting firms, financially unconstrained firms, and SOEs. This heterogeneity aligns with the tax incentive created by environmental policies like the ETS, providing further support that the documented financing responses arise from the ETS.

Table 8: Ownership Structures and Financing Responses to the ETS

Dependent Variable: *Liability/BA*

| | Non-SOEs | | | SOEs | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.039*** | 0.032*** | 0.031*** | -0.004 | 0.001 | 0.002 |
| | (0.000) | (0.000) | (0.000) | (0.697) | (0.870) | (0.803) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variables (Baseline) | | Yes | Yes | | Yes | Yes |
| Additional Control Variables | | | Yes | | | Yes |
| Observations | 8,732 | 8,732 | 8,705 | 7,010 | 7,010 | 6,991 |
| Adjusted $R^2$ | 0.774 | 0.791 | 0.793 | 0.813 | 0.831 | 0.831 |

Note: The *Liability/BA* of non-SOEs and SOEs are 38.6% and 52.0%. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

#### 4.4.4 The Dynamics of the Heterogeneous Leverage Responses

We explore the dynamic effects of the ETS on financial leverage using six different samples categorized by environmental performances, financial constraints, and ownership structures. The dynamic effects are estimated for each sample, and the corresponding estimates are presented in Figures OA3, OA4, and OA5 in the online Appendix.

The figures exhibit three key features. First, all the estimates are statistically insignificant ex ante across the six samples. The results provide robust evidence that treated and untreated firms shared parallel trends in the financial structure in the absence of the ETS. Moreover, we observe an increase in the leverage ratio of the treated firms that are high-polluting, financially constrained, and non-SOEs immediately following the ETS implementation. This suggests that the ETS is likely the driving force behind the observed financing responses. Furthermore, most of the estimates are insignificant ex post among firms that are low-polluting, financially unconstrained, and SOEs. This suggests that if the ETS had not affected the financial structures of high-polluting firms, financially constrained firms, or non-SOEs, these firms would have also exhibited parallel trends in the financial structure ex post. These analyses further enhance the credibility of our identifying assumption and provide additional support for the notion that the financing responses result from the ETS.

Before closing this section, we briefly explain the significance of our findings. The literature consistently finds evidence that firms adopt a more conservative financial structure in response to climate risk (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023; Yip et al., 2024). Therefore, the literature argues that environmental policies, similar to other negative shocks (Simintzi et al., 2015; Serfling, 2016; Geng et al., 2021), increase operating leverage. In response, firms reduce financial leverage to balance the operating and financing risk. Nevertheless, we find strong and consistent evidence that corporate financing responses to market-based policy can be different. In contrast to this literature, we find that firms tend to adopt a more aggressive financing policy to the ETS. Therefore, our findings indicate that market-based policy, such as the ETS, is not necessarily like other negative shocks leading to a more conservative financial structure. The next section explores a potential explanation for the deviation of our results from the literature.

# 5 The Purpose of Financing

This section aims to shed light on the underlying reasons explaining why the average leverage ratio increases post-ETS. Specifically, we investigate whether firms increase their financial leverage to support their operating or investing activities. We explore two competing hypotheses in this regard.

First, we examine the compliance cost hypothesis, which suggests that environmental policy is likely to raise operating costs (Jaffe et al., 1995). The effects of the ETS on operating leverage are estimated using equation (1). Second, we explore the Porter Hypothesis, which posits that environmental policies can stimulate innovation and enhance productivity. By revisiting the Porter Hypothesis in section 5.2, we aim to investigate whether firms direct their financial resources to foster innovation and whether the ETS enhances corporate productivity.

## 5.1 The Compliance Cost Hypothesis

According to the compliance cost hypothesis, environmental policy, such as ETS, is likely to increase the operating cost. If the ETS does not significantly affect sales revenue, we expect to observe an increase in operating leverage and a decrease in net cash flows from operating activities (NCFOA). In this section, we test the hypothesis by answering whether ETS affects operating leverage, the NCFOA, costs of goods sold, and sales revenues. Following the literature (Kim et al., 2018; Albuquerque et al., 2019; Chen et al., 2019; Dou et al., 2021; Dang et al., 2022), we identify two measures of operating leverage recently developed by Kahl et al. (2019) and Novy-Marx (2011). For simplicity, we label them as *KLNOL* and *NMOL*. We also estimate the policy effect on the ratio of NCFOA to total assets (*NCFOA/BA*), the ratio of costs of goods sold to total assets (*COGS/BA*), and the ratio of sales revenue to total assets (*Sales/BA*). The effects of the ETS are estimated from equation (1).

Table 9 presents the results. In columns (1) through (5), the dependent variables are *KLNOL*, *NMOL*, *NCFOA/BA*, *COGS/BA*, and *Sales/BA* in columns (1) through (5). Panel A provides an overview of the policy effects, while Panel B examines the heterogeneous effects by replacing *ETS* × *Post* with *ETS* × *Post* × *HP Firm* and *ETS* × *Post* × *LP Firm*. In Panel C, we investigate the relationship between the financing response to the ETS and operating activities. For this purpose, we estimate equation (1) by substituting *ETS* × *Post* with *ETS* × *Post* × *LR Up* and *ETS* × *Post* × *LR Down*. Here, *LR Up* represents a dummy variable for firms with a higher average leverage ratio in the post-policy period compared to the pre-policy period, while *LR Down* is a dummy variable for the remaining firms in our sample.

We find no support for the compliance cost hypothesis. In columns (1) to (5) of Panels A, B, and C, all of the main estimates are statistically insignificant at conventional levels. The results indicate no evidence of the ETS affecting operating leverage, including costs, sales, or net cash flows from operating activities. These findings hold across firms, regardless of their environmental performance or their financing responses to the ETS. Overall, we fail to find support for the compliance cost hypothesis, irrespective of environmental performance or financing responses to the ETS.

## 5.2 The Porter Hypothesis

This section examines the Porter Hypothesis. Drawing inspiration from the Porter Hypothesis (Jaffe and Palmer, 1997), we investigate the effects of the ETS on innovation and productivity. Following Li (2011), we measure innovation by the ratio of R&D expenditure to sales revenue (*RD/Sales*). To quantify productivity, we use a commonly used measure of TFP ($\text{TFP}_{OP}$) proposed by Olley and Pakes (1996) and technical efficiency (*Tech. Efficiency*) proposed by Wang and Ho (2010).[5] In Table 10, we present the regression results in Panels A and B, where the dependent variables are *RD/Sales*, $\ln(\text{TFP}_{OP})$, and *Tech. Efficiency* in columns (1)-(2), (3)-(4), and (5)-(6).

The findings in Panel A provide support for both the weak and strong versions of the Porter Hypothesis. Columns (1), (3), and (5) reveal positive and statistically significant estimates, indicating that the ETS has increased R&D expenditure, enhanced TFP, and improved technical efficiency. To further examine the relationships, we replace *ETS* × *Post* with *ETS* × *Post* × *HP Firm* and *ETS* × *Post* × *LP Firm* in columns (2), (4), and (6). The estimates associated with *ETS* × *Post* × *HP Firm* remain positive and significant, while those estimates associated with *ETS* × *Post* × *LP Firm* are relatively smaller

[5]To ensure the robustness of our findings, we also adopt another popular measure of TFP proposed by (Levinsohn and Petrin, 2003) ($\text{TFP}_{LP}$). Table OA9 reports the effect of the ETS on $\text{TFP}_{LP}$. Our conclusion remains quantitatively unchanged.

Table 9: Emissions Trading Scheme and Operating Leverage

| Panel A: The Effects of ETS on Operating Leverage | | | | | |
|---|---|---|---|---|---|
| | *KLNOL* | *NMOL* | *NCFOA/BA* | *COGS/BA* | *Sales/BA* |
| | (1) | (2) | (3) | (4) | (5) |
| *ETS* × *Post* | 0.003 | 0.003 | -0.002 | 0.004 | 0.007 |
| | (0.595) | (0.796) | (0.594) | (0.709) | (0.561) |
| Firm FE | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Observations | 14,958 | 15,755 | 15,755 | 15,755 | 15,755 |
| Adjusted $R^2$ | 0.684 | 0.863 | 0.341 | 0.864 | 0.856 |
| **Panel B: The Heterogeneous Effects of ETS on Operating Leverage** | | | | | |
| | *KLNOL* | *NMOL* | *NCFOA/BA* | *COGS/BA* | *Sales/BA* |
| | (1) | (2) | (3) | (4) | (5) |
| *ETS* × *Post* × *HP Firm* | 0.006 | 0.007 | -0.000 | 0.008 | 0.013 |
| | (0.351) | (0.662) | (0.962) | (0.551) | (0.382) |
| *ETS* × *Post* × *LP Firm* | -0.004 | -0.004 | -0.005 | -0.004 | -0.005 |
| | (0.553) | (0.858) | (0.277) | (0.846) | (0.823) |
| Firm FE | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Observations | 14,938 | 15,735 | 15,735 | 15,735 | 15,735 |
| Adjusted $R^2$ | 0.684 | 0.863 | 0.308 | 0.864 | 0.855 |
| p-value | 0.250 | 0.677 | 0.417 | 0.598 | 0.468 |
| **Panel C: The Financial Leverage and Operating Leverage** | | | | | |
| | *KLNOL* | *NMOL* | *NCFOA/BA* | *COGS/BA* | *Sales/BA* |
| | (1) | (2) | (3) | (4) | (5) |
| *ETS* × *Post* × *LR Up* | 0.003 | 0.014 | -0.003 | 0.016 | 0.018 |
| | (0.568) | (0.362) | (0.387) | (0.274) | (0.259) |
| *ETS* × *Post* × *LR Down* | 0.002 | -0.014 | 0.001 | -0.014 | -0.010 |
| | (0.841) | (0.439) | (0.822) | (0.419) | (0.621) |
| Firm FE | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Observations | 14,730 | 15,522 | 15,522 | 15,522 | 15,522 |
| Adjusted $R^2$ | 0.673 | 0.863 | 0.338 | 0.865 | 0.856 |
| p-value | 0.854 | 0.219 | 0.198 | 0.167 | 0.253 |

Note: *HP Firm* and *LP Firm* are dummy variables for high- and low-polluting firms. *LR Up* (*LR Down*) is a dummy variable for firms that increased (did not increase) their leverage ratio ex post. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

and statistically insignificant at conventional levels. These results suggest that the ETS stimulates innovation, enhances productivity, and improves technical efficiency primarily among high-polluting firms, providing support for the Porter Hypothesis (Porter, 1991; Jaffe and Palmer, 1997; Ambec et al., 2013).

Moving to Panel B, we modify equation (1) by replacing *ETS* × *Post* with *ETS* × *Post* × *FC Firm* and *ETS* × *Post* × *FU Firm*, focusing on high-polluting firms in columns (1), (3), and (5), and low-polluting firms in columns (2), (4), and (6). The results indicate that the effects on innovation, TFP, and technical efficiency vary significantly depending on corporate environmental performances and financial constraints. Specifically, the observed effects are concentrated among firms with poor environmental performances and tight financial constraints, while high-polluting firms without financial constraints and low-polluting firms do not exhibit similar effects. The estimates also suggest substantial productivity gains, with financially constrained, high-polluting firms experiencing an average TFP increase of 2.3 percent. In terms of technical efficiency, these firms operate 7.8 percentage points closer to the production frontier after the implementation of the ETS.

In Panel C, we provide additional evidence for the interplay between financial leverage, R&D expenditure, TFP, and technical efficiency. By replacing *ETS* × *Post* with *ETS* × *Post* × *LR Up* and *ETS* × *Post* × *LR Down* in equation (1), we observe positive and statistically significant estimates associated with *ETS* × *Post* × *LR Up*, while the estimates associated with *ETS* × *Post* × *LR Down* are materially small and statistically insignificant at conventional levels. Our analysis provides evidence of a significant increase in R&D expenditures, TFP, and technical efficiency only when treated firms increase their financial leverage post-implementation. Our suggestive evidence indicates that the purpose of the increased financial leverage is to finance the innovation effort.[6]

Our findings are indeed surprising. While it makes economic sense that the ETS incentivizes high-polluting firms to increase their R&D expenditures, it is counter-intuitive to observe significant innovation and productivity gains from financially constrained firms rather than their unconstrained counterparts. If financially constrained firms are motivated to increase R&D expenditures, why aren't their unconstrained counterparts motivated?

[6]We conduct a battery of robust checks for the results. For example, we estimate the policy effects using the two popular matching methods (PSM and EB) to balance the covariates (See Tables OA10 and OA11). In addition, we control firm characteristics in our model (See Table OA12). Furthermore, we estimate the effect of the ETS on an alternative measure of TFP (See Table OA9). Our conclusion is qualitatively unchanged.

Table 10: Emissions Trading Scheme, Innovation, and Productivity

| Panel A: The Effects of ETS on R&D, TFP, and Technical Efficiency | | | | | | |
|---|---|---|---|---|---|---|
| | *RD/Sales* | | ln(*TFP*$_{OP}$) | | *Tech. Efficiency* | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS × Post* | 0.003** | | 0.009*** | | 0.029*** | |
| | (0.038) | | (0.004) | | (0.005) | |
| *ETS × Post × HP Firm* | | 0.005*** | | 0.016*** | | 0.052*** |
| | | (0.006) | | (0.000) | | (0.000) |
| *ETS × Post × LP Firm* | | -0.001 | | -0.004 | | -0.014 |
| | | (0.758) | | (0.397) | | (0.398) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,754 | 15,734 | 15,106 | 15,094 | 15,732 | 15,712 |
| Adjusted $R^2$ | 0.596 | 0.596 | 0.851 | 0.851 | 0.508 | 0.508 |
| p-value | — | 0.036 | — | 0.000 | — | 0.001 |

| Panel B: The Heterogeneous Effects of ETS on R&D, TFP, and Technical Efficiency | | | | | | |
|---|---|---|---|---|---|---|
| | *RD/Sales* | | ln(*TFP*$_{OP}$) | | *Tech. Efficiency* | |
| | HP Firm | LP Firm | HP Firm | LP Firm | HP Firm | LP Firm |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS × Post × FC Firm* | 0.007*** | 0.006 | 0.023*** | 0.007 | 0.078*** | 0.014 |
| | (0.002) | (0.184) | (0.000) | (0.536) | (0.000) | (0.693) |
| *ETS × Post × FU Firm* | 0.000 | -0.001 | 0.004 | -0.001 | -0.001 | 0.010 |
| | (0.951) | (0.695) | (0.362) | (0.866) | (0.945) | (0.632) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 11,338 | 4,227 | 10,934 | 4,008 | 11,318 | 4,225 |
| Adjusted $R^2$ | 0.599 | 0.515 | 0.823 | 0.882 | 0.521 | 0.459 |
| p-value | 0.025 | 0.159 | 0.008 | 0.511 | 0.000 | 0.918 |

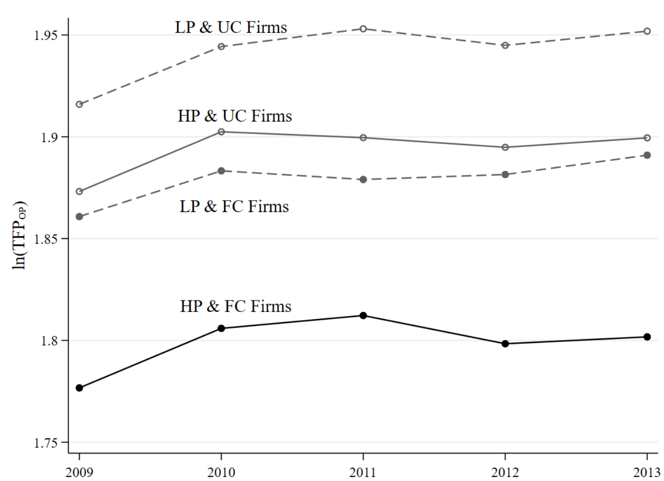
| Panel C: The Interplay between Financing and Investment Responses | | | |
|---|---|---|---|
| | *RD/Sales* | ln(*TFP*$_{OP}$) | *Tech. Efficiency* |
| | (1) | (2) | (3) |
| *ETS × Post × LR Up* | 0.006*** | 0.017*** | 0.048*** |
| | (0.001) | (0.000) | (0.000) |
| *ETS × Post × LR Down* | -0.002 | -0.004 | -0.003 |
| | (0.147) | (0.407) | (0.855) |
| Firm FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 15,521 | 14,886 | 15,499 |
| Adjusted $R^2$ | 0.587 | 0.851 | 0.505 |
| p-value | 0.000 | 0.000 | 0.008 |

Note: *HP Firm* (*LP Firm*) is a dummy variable for high-polluting (low-polluting) firms. *FC Firm* (*FU Firm*) is a dummy variable for financially constrained (unconstrained) firms. *LR Up* (*LR Down*) is a dummy variable for firms that increased (did not increase) their leverage ratio ex post. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

To understand the underlying reason, we explore the fundamental difference between constrained and unconstrained firms that leads to the diverse innovation incentives created by the ETS. One of the potential reasons is that the ETS may provide the least productive firms with the most incentives to catch up with the latest production technology. If financially constrained, high-polluting firms were less productive than their unconstrained counterparts before the implementation of the ETS, the ETS could create the most incentives for financially constrained firms to engage in innovation.

To support our argument, we plot the average TFP by corporate environmental performances and financial constraints in Table 3. We find that before the implementation of the ETS, firms with poor environmental performances and tight financial constraints tend to be less productive, consistent with the literature (Campello et al., 2010; Dang et al., 2022). Our finding suggests that financially constrained, high-polluting firms had the most innovation incentives created by the ETS, partly explaining why the innovation and productivity gains are concentrated among financially constrained, high-polluting firms.[7]

Figure 3: Productivity Dynamics 2009-2013




Note: We measure productivity by $\ln$*(TFP$_{OP}$)*. *HP Firm* and *LP Firm* indicates high-polluting and low-polluting firms. *FC Firm* and *FU Firm* indicates firms with relatively tight and loose financial constraints.

Our findings significantly diverge from the literature on the relationship between financial structure and climate risk (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger

[7]We plot similar figures using TFP$_{LP}$ and technical efficiency in Figure OA6. Our conclusion remains unchanged.

and Moreau, 2023; Yip et al., 2024). Previous studies, including Dang et al. (2022) and Ginglinger and Moreau (2023), have shown evidence that climate risk increases operating leverage, as implied by the compliance cost hypothesis. Moreover, these studies find that climate risk raises the risk of financial distress, leading to higher costs of debt (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023). The literature generally supports the notion that firms adopt a more conservative financial structure in response to climate risk, particularly among financially constrained firms. Yip et al. (2024) argue that without sufficient external financing, firms may struggle to adjust their financial structure and optimize their input combination. Yip et al. (2024) also provide evidence that environmental regulations in China result in productivity losses. The significant difference in the firm responses between the ETS and other climate risks can be explained by a narrow version of the Porter Hypothesis (Porter, 1991; Jaffe and Palmer, 1997). This version of the Porter Hypothesis argues that environmental policy can stimulate innovation when the policy instrument is stringent and flexible, such as market-based environmental policy. Nguyen and Phan (2020), Dang et al. (2022), Ginglinger and Moreau (2023), and Yip et al. (2024) seem to support the compliance cost hypothesis, mainly because they study either non-market-based environmental policy or climate physical risk rather than market-based policy. While the literature agrees that firms adopt a more conservative financial structure in response to climate risk, this paper contributes by demonstrating that the financing and investment responses to a market-based environmental policy, such as the ETS, can differ significantly.

Meanwhile, our findings raise another question. If the ETS encourages financially constrained firms to innovate, how do they finance the R&D expenditures? They did not engage in innovation partly because they found it challenging to access external finance. If they can easily access external finance, such as bank loans and bond debt, to support the innovation, they should have done it ex ante. Hence, we answer this question in the next session.

# 6 The Sources of Financing

To sharpen our understanding of the financing and investment responses to the ETS, we delve deeper into the source of financing. In this section, we begin by estimating the policy effect on the cost of debt, which holds significant informative value. The literature provides evidence suggesting that loaners tended to charge high-polluting firms a higher interest rate (Chava, 2014; De Greiff et al., 2018; Herbohn et al., 2019; Fard et al., 2020; Huang et al., 2021). Therefore, if the average cost of debt for high-polluting firms increased ex post, we would anticipate these firms to seek alternative avenues of financing other than debt. Meanwhile, trade credit, which accounts for approximately 73% of the non-interest-bearing liabilities (NIBL), would become relatively more affordable due to the elevated cost of debt. Consequently, we hypothesize that the ETS would likely lead to an increase in the NIBL, particularly through trade credit, for high-polluting firms.

Table 11: The Effect of the ETS on the Costs of Debt

| | $CoD_1$ | $CoD_1$ | $CoD_2$ | $CoD_2$ |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| *ETS* × *Post* | 0.011** | | 0.014*** | |
| | (0.017) | | (0.006) | |
| *ETS* × *Post* × *HP Firm* | | 0.018*** | | 0.019*** |
| | | (0.004) | | (0.002) |
| *ETS* × *Post* × *LP Firm* | | -0.001 | | 0.003 |
| | | (0.859) | | (0.678) |
| Firm FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes |
| Observations | 15,755 | 15,735 | 15,755 | 15,735 |
| Adjusted $R^2$ | 0.610 | 0.610 | 0.640 | 0.640 |
| p-value | — | 0.022 | — | 0.082 |

Note: The dependent variables are the cost of debt. *HP Firm* and *LP Firm* are dummy variables for high- and low-polluting firms. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

To estimate the impact of the ETS on the cost of debt, we employ equation (1) and adopt two measures of the cost of debt, namely $CoD_1$ and $CoD_2$, following the methodology of Regenburg and Seitz (2021). Detailed definitions of these variables can be found in Table A1. The findings are presented in Table 11. Columns (1)-(2) and (3)-(4) display the results with $CoD_1$ and $CoD_2$ as dependent variables, respectively. In columns (1) and (3), the positive and statistically significant estimates provide evidence that the ETS increased the cost of debt ex post. Furthermore, in columns (2) and (4), the coefficients associated with *ETS* × *Post* × *HP Firm* are positive and statistically significant at all conventional levels, while the coefficients associated with *ETS* × *Post* × *LP Firm* are multiple times smaller and insignificant at any conventional level. Our analysis offers empirical support for the notion that the ETS resulted in an elevated average cost of debt for high-polluting firms, while such an effect is not observed among low-polluting firms. These findings align with the literature (Chava, 2014; De Greiff et al., 2018; Herbohn et al., 2019; Fard et al., 2020; Huang et al., 2021). Given the increased cost of debt, we anticipate the ETS to drive high-polluting firms towards a more aggressive financial structure through NIBL rather than debt.

## 6.1 Debt and Non-Interest-Bearing Liabilities

To rigorously test our hypothesis, we initiate our analysis by examining the impact of the ETS on debt and its primary components. Specifically, we estimate the effects on the ratio of total debt to total assets at book value (*Debt Ratio*), the ratio of bank loans to total assets at book value (*Bank Loan Ratio*), and the ratio of bonds to total assets at book value (*Bond Ratio*) using equation (1).[8]

We present the results of our regression analysis in Panel A of Table 12. The columns (1)-(2), (3)-(4), and (5)-(6) use the following dependent variables: *Debt Ratio*, *Bank Loan Ratio*, and *Bond Ratio*, respectively. To further examine the effects on firms with different environmental performances, we modify equation (1) in columns (2), (4), and (6) by replacing *ETS* × *Post* with *ETS* × *Post* × *HP Firm* and *ETS* × *Post* × *LP Firm*. The estimates in columns (1), (3), and (5) reveal no statistically significant effects. In columns (2), (4), and (6), estimates associated with *ETS* × *Post* × *HP Firm* and *ETS* × *Post* × *LP Firm* are also insignificant. Our results suggest that there are no systematic changes in debt, bank loans, or corporate bonds, regardless of the environmental performance.

Next, we explore the effect of the ETS on NIBL. The previous section provides evidence that the ETS stimulates innovation and enhances productivity among firms with poor environmental performances and tight financial constraints. If the effect of the ETS on the financial structure operates through the NIBL, we expect the effect to be more prominent in firms with poor environmental performances and tight financial constraints. We estimate the effect on the ratio of the NIBL to total assets at book value (*NIBL/BA*)

[8]We follow Huang et al. (2023) to construct the bank loan ratio.

Table 12: The Effects of the ETS on the Liabilities Components

| Panel A: The Effects of ETS on Debt | | | | | | |
|---|---|---|---|---|---|---|
| | *Debt Ratio* | | *Bank Loan Ratio* | | *Bond Ratio* | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.004 | | 0.005 | | -0.002 | |
| | (0.455) | | (0.333) | | (0.418) | |
| *ETS* × *Post* × *HP Firm* | | 0.007 | | 0.008 | | -0.000 |
| | | (0.220) | | (0.137) | | (0.929) |
| *ETS* × *Post* × *LP Firm* | | -0.001 | | -0.000 | | -0.004 |
| | | (0.901) | | (0.982) | | (0.168) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,755 | 15,735 | 15,755 | 15,735 | 15,755 | 15,735 |
| Adjusted $R^2$ | 0.799 | 0.799 | 0.752 | 0.752 | 0.457 | 0.457 |
| p-value | — | 0.408 | — | 0.392 | — | 0.256 |

| Panel B: The Effects of ETS on Non-Interest Bearing Liabilities | | | | | | |
|---|---|---|---|---|---|---|
| | *NIBL/BA* | | *NIBCL/BA* | | *NIBNCL/BA* | |
| | HP Firm | LP Firm | HP Firm | LP Firm | HP Firm | LP Firm |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* × *FC Firm* | 0.025*** | 0.009 | 0.023*** | 0.011 | 0.002 | -0.001 |
| | (0.001) | (0.540) | (0.002) | (0.431) | (0.384) | (0.836) |
| *ETS* × *Post* × *FU Firm* | 0.008 | 0.001 | 0.009 | 0.003 | -0.000 | -0.001 |
| | (0.290) | (0.860) | (0.253) | (0.598) | (0.836) | (0.575) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 11,339 | 4,227 | 11,339 | 4,227 | 11,339 | 4,227 |
| Adjusted $R^2$ | 0.756 | 0.847 | 0.756 | 0.851 | 0.586 | 0.632 |
| p-value | 0.123 | 0.616 | 0.047 | 0.598 | 0.458 | 0.991 |

Note: *HP Firm* and *LP Firm* are dummy variables for high- and low-polluting firms. *FC Firm* and *FU Firm* are dummy variables for financially constrained and unconstrained firms. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

using equation (1) and present the results in Panel B of Table 12. In columns (1) and (2), we focus on high- and low-polluting firms, respectively.

The results indicate that the ETS increases the financial structure mainly through NIBL. In column (1), we observe a positive and statistically significant estimate associated with *ETS* × *Post* × *FC Firm*. However, the coefficient associated with *ETS* × *Post* × *FU Firm* is considerably smaller and insignificant at conventional levels. These findings support our hypothesis that the ETS tends to increase the NIBL of the treated firms with poor environmental performances and financial constraints. Conversely, the estimates in column (2) associated with *ETS* × *Post* × *FC Firm* and *ETS* × *Post* × *FU Firm* are statistically insignificant, providing no evidence for a significant change in the NIBL for low-polluting firms.

We further investigate whether the firms increase their financial leverage through non-interest-bearing current liabilities (NIBCL) or non-interest-bearing non-current liabilities (NIBNCL). We may expect firms to increase the NIBNCL to finance R&D expenditure. However, the ETS increased the financial leverage and R&D investment for financially constrained firms. These firms may find it more challenging to secure long-term financing and hence expand their financial bases from the NIBCL. We present the result in Panel B of Table 12. The dependent variables are the ratio of NIBCL to total assets at book value (*NIBCL/BA*) and the ratio of NIBNCL to total assets at book value (*NIBNCL/BA*) in columns (3)-(4) and (5)-(6).

Indeed, the regression results reveal that the effects observed in columns (1)-(2) and (3)-(4) are similar. This suggests that firms expand their financial bases primarily through the NIBCL, and this effect is concentrated among financially constrained, high-polluting firms. In contrast, all of the main estimates in columns (5) and (6) are insignificant, providing no evidence that the ETS incentivizes firms to expand financial bases through NIBNCL, irrespective of their environmental performance or degree of financial constraint. Thus, while the ETS leads to increased R&D expenditure and productivity among financially constrained, high-polluting firms, the heterogeneity in the response of NIBL and NIBCL aligns with the incentives created by the ETS.

## 6.2 Alternative Financing Resources

In this section, our objective is to explore whether firms seek multiple types of financial resources to finance the increased R&D expenditure resulting from the ETS. Specifically, we investigate the impact of the ETS on trade credit, dividend policy, and tax avoidance. We focus on trade credit because it represents a significant portion of NIBL. Our analysis helps uncover the mechanism through which the ETS increases NIBL, while also addressing the limited research on the relationship between climate risk and trade credit, despite the crucial role played by trade credit in businesses (Rajan and Zingales, 1995; Petersen and Rajan, 1997; Demirguc-Kunt and Maksimovic, 2001; Gofman and Wu, 2022). We measure trade credit (*TC*) following the approach used by Fisman and Love (2003) and Wen et al. (2021), which calculate the ratio of the sum of accounts payable, notes payable, and advanced payments to total assets. Given our evidence of a significant increase in NIBL, we anticipate that firms' *TC* will also experience a subsequent increase.

Additionally, motivated by the pecking order theory, we examine the effect of the ETS on corporate dividend policy. The pecking order theory suggests that firms prioritize internal finance over external debt, as the cost of financing rises with asymmetric information (Myers and Majluf, 1984; Graham and Harvey, 2001; Hovakimian et al., 2001; Leary and Roberts, 2005). Accordingly, we hypothesize that firms will adopt a more conservative dividend policy following the implementation of the ETS. To test this hypothesis, we analyze whether the dividend payout ratio (*DPR*) of treated firms decreases ex post.

Furthermore, we explore the possibility that the ETS induces corporate tax avoidance behaviors, aiming to uncover the source of finance utilized by firms after the implementation of the ETS. Prior research suggests that the ETS may lead to increased tax avoidance (Geng et al., 2021; Compagnie et al., 2023). To test this hypothesis, we employ the differential effective tax rate (*DETR*) proposed by Chen et al. (2021). The *DETR* reflects the deviation of a firm's effective tax rate from its statutory tax rate, with a higher value indicating greater tax avoidance.

Our results, presented in Table 13, examine the dependent variables *TC*, *DPR*, and *DETR* in columns (1)-(2), (3)-(4), and (5)-(6), respectively. We estimate the overall effects of the ETS in columns (1), (3), and (5), as well as the heterogeneous effects in columns (2), (4), and (6). In column (1), the positive DID estimate suggests that the average

Table 13: The Effects of ETS on Trade Credit, Dividend Policy, and Tax Avoidance

| | *TC* | | *DPR* | | *DETR* | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.005 | | -0.043*** | | 0.010* | |
| | (0.161) | | (0.001) | | (0.083) | |
| *ETS* × *Post* × *HP Firm* | | 0.009** | | -0.048*** | | 0.016** |
| | | (0.048) | | (0.002) | | (0.018) |
| *ETS* × *Post* × *LP Firm* | | -0.003 | | -0.034* | | -0.002 |
| | | (0.512) | | (0.077) | | (0.845) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,755 | 15,735 | 11,011 | 10,992 | 13,854 | 13,854 |
| Adjusted $R^2$ | 0.810 | 0.809 | 0.374 | 0.374 | 0.290 | 0.290 |
| p-value | — | 0.045 | — | 0.515 | — | 0.079 |

Note: The dependent variables are *TC*, *DPR*, and *DETR* in columns (1)-(2), (3)-(4), and (5)-(6). *HP Firm* and *LP Firm* are dummy variables for high- and low-polluting firms. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

trade credit of treated firms increased ex post, although the estimate is not statistically significant. However, in column (2), the estimate associated with *ETS* × *Post* × *HP Firm* is positive and statistically significant at the five percent level, while the estimate associated with *ETS* × *Post* × *LP Firm* is negative and insignificant. This indicates that the ETS incentivizes firms to adopt a more aggressive financial structure through trade credit, a significant component of NIBL, particularly among high-polluting firms.

The trade-credit preference of high-polluting firms can be partly attributed to the relative affordability of trade credit compared to debt, especially considering the increased cost of debt resulting from the ETS. Although previous studies have provided limited evidence on the causal relationship between environmental policy and trade credit, our findings contribute to the literature by documenting the effect of the ETS on trade credit.

Additionally, our findings reveal that firms tend to adopt a more conservative dividend policy following the implementation of the ETS. In column (3), the main coefficient is negative and significant for all conventional significance levels, suggesting a decline in the average *DPR* after the ETS. In column (4), the main coefficients are negative, with the estimate being significant for high-polluting firms and marginally significant for low-polluting firms. While our analysis in section 6.1 demonstrates that the ETS does not substantially impact financial leverage through external finance, such as bank loans or corporate bonds, our findings in this section lend support to the notion that the ETS incentivizes firms to adopt a more conservative dividend policy. These results are consistent with the predictions of the pecking order theory (Myers and Majluf, 1984; Graham and Harvey, 2001; Hovakimian et al., 2001; Leary and Roberts, 2005).

Furthermore, our analysis suggests that the ETS induces corporate tax avoidance behaviors. We observe a negative and significant estimate in column (5), indicating a decline in the average *DETR* after the ETS. The estimates in column (6) indicate that the effect of the ETS on tax avoidance behaviors is concentrated among high-polluting firms rather than low-polluting firms. This finding speaks to the literature. Geng et al. (2021) argues that environmental policy increases cost and operating risks. To mitigate the risk, firms may engage in more tax avoidance to preserve short-term cash flows. However, our analysis in section 5.1 does not provide statistical support for the hypothesis that the ETS affects operating leverage, including sales, costs, or net cash flow from operating activities. Therefore, our findings contribute to the literature by offering an alternative explanation for the observed increase in tax avoidance: firms seek alternative financial resources to finance their heightened R&D expenditure.

In Table OA13, we present additional evidence that the ETS increases financial leverage, R&D expenditure, and productivity of treated firms, but the effect can only be found among firms that increase their trade credit, adopt a more conservative dividend policy, and engage in more tax avoidance ex post. Overall, our findings suggest that financially constrained firms actively seek alternative financial resources to support their innovation activities. These firms are reluctant to rely on bank loans and bonds to meet their financial obligations partly because of their financial constraints and partly because of the increased cost of debt resulting from environmental policies. Therefore, they actively pursue multiple, less expensive forms of finance to raise capital.

# 7 The Consequences of Financing

In this section, we perform additional tests to corroborate and sharpen the interpretation of our main results. We hypothesize that the EST poses a liquidity risk to high-polluting firms for two reasons. First, the ETS increases the average cost of debt for high-polluting firms as documented in section 6 and literature (Chava, 2014; De Greiff et al., 2018; Herbohn et al., 2019; Fard et al., 2020; Huang et al., 2021). Moreover, we show that high-polluting firms seek alternative sources of finance to support their innovation activities, including the NIBCL through trade credit. These two channels combined may lead to increased liquidity and default risk for high-polluting firms. In contrast, we do not anticipate significant changes in the liquidity or default risk of low-polluting firms. In this section, we present empirical evidence to support these expectations.

## 7.1 Liquidity Risk and Default Risk

We estimate the effects of the ETS on liquidity and default risk from equation (1). Table 14 presents the results. In Panel A, we estimate the effects of the ETS on liquidity and default risk. Columns (1)-(3) and (4) report the effects on liquidity and default risk, respectively. Liquidity risk is assessed through three widely-used liquidity ratios: *Current Ratio*, *Quick Ratio*, and *Cash Ratio*. Default risk is measured by the distance-to-default (DtD) according to the KMV model. In columns (1)-(4) of Panel A, the results consistently show negative and statistically significant estimates, suggesting a decline in the three liquidity ratios and an increase in default risk for treated firms. These findings support our hypothesis that the ETS implementation tends to diminish corporate liquidity while elevating default risk.

In Panel B, we replace *ETS* × *Post* with *ETS* × *Post* × *HP Firm* and *ETS* × *Post* × *LP Firm* in equation (1), where *HP Firm* and *LP Firm* are dummy variables for high- and low-polluting firms. In columns (1) to (4), the estimates associated with *ETS* × *Post* × *HP Firm* are consistently negative and statistically significant. However, we observe small and statistically insignificant estimates associated with *ETS* × *Post* × *LP Firm* across columns (1) to (4). These findings support our expectation that the ETS reduces liquidity and elevates default risk for high-polluting firms. The conclusion holds when alternative liquidity measures are employed.

## 7.2 Financial Leverage, Liquidity, and Default Risk

Next, we explore the relationship between the financing responses and the two risks. In the following analysis, we investigate whether the ETS decreases the liquidity of firms

Table 14: The Effects of the ETS on the Liquidity Ratio and Default Risk

| **Panel A: The Effect of the ETS on Liquidity** | | | | |
|---|---|---|---|---|
| | Liquidity Ratios | | | Default Risk |
| | *Current Ratio* | *Quick Ratio* | *Cash Ratio* | *DtD* |
| | (1) | (2) | (3) | (4) |
| *ETS* × *Post* | -0.963*** | -0.890*** | -0.716** | -0.149** |
| | (0.005) | (0.004) | (0.011) | (0.026) |
| Firm FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes |
| Observations | 15,755 | 15,755 | 15,755 | 15,755 |
| Adjusted $R^2$ | 0.495 | 0.518 | 0.455 | 0.626 |
| **Panel B: The Heterogeneous Effects of the ETS on Liquidity** | | | | |
| | Liquidity Ratios | | | Default Risk |
| | *Current Ratio* | *Quick Ratio* | *Cash Ratio* | *DtD* |
| | (1) | (2) | (3) | (4) |
| *ETS* × *Post* × *HP Firm* | -1.418*** | -1.309*** | -1.104*** | -0.187** |
| | (0.005) | (0.004) | (0.008) | (0.030) |
| *ETS* × *Post* × *LP Firm* | -0.129 | -0.123 | -0.002 | -0.074 |
| | (0.662) | (0.639) | (0.993) | (0.428) |
| Firm FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes |
| Observations | 15,735 | 15,735 | 15,735 | 15,735 |
| Adjusted $R^2$ | 0.496 | 0.519 | 0.456 | 0.625 |
| p-value | 0.026 | 0.023 | 0.014 | 0.359 |

Note: The dependent variables are *Current Ratio*, *Quick Ratio*, *Cash Ratio*, and *DtD* in columns (1) through (4). *HP Firm* and *LP Firm* are dummy variables for high- and low-polluting firms. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

that experienced an increase in their average leverage ratio after the introduction of the ETS. To explore this relationship, we introduce two variables, *ETS* × *Post* × *LR Up* and *ETS* × *Post* × *LR Down*, into equation (1). The estimates are presented in Panel A of Table 15. In columns (1) to (3), the dependent variables are the *Current Ratio*, *Quick Ratio*, and *Cash Ratio*.

The results indicate a negative association between leverage responses to the ETS and liquidity. Across all conventional levels of significance, the estimates associated with *ETS* × *Post* × *LR Up* are consistently negative and statistically significant. On the other hand, the estimates associated with *ETS* × *Post* × *LR Down* are positive, relatively smaller in magnitude, and only marginally significant. These findings suggest that there is a systematic decrease in liquidity among firms that expand their financial bases after the introduction of the ETS.

In Panel B, we explore the relationship between liquidity and default risk. We replace *ETS* × *Post* with *ETS* × *Post* × *FL Liquid Up* and *ETS* × *Post* × *Liquid Down* in equation (1). *Liquid Up* is a dummy variable, which equals one if the average liquidity ratio of a firm increased after 2014, and zero otherwise. *Liquid Down* is a dummy variable, which equals one if the average liquidity ratio of a firm did not increase after 2014, and zero otherwise. The estimates are presented in Panel B of Table 15. In all columns, the dependent variable is *DtD*, while liquidity is measured by the *Current Ratio*, *Quick Ratio*, and *Cash Ratio* in columns (1), (2), and (3), respectively.

The results suggest that the ETS tends to increase the default risk of firms that experience a decrease in liquidity after the ETS implementation. Across all conventional levels of significance, the estimates associated with *ETS* × *Post* × *Liquid Down* are consistently negative and statistically significant, indicating that firms with reduced liquidity after the ETS tend to have an increased default risk. Conversely, the estimates associated with *ETS* × *Post* × *Liquid Up* are positive, small in magnitude, and statistically insignificant at conventional levels. This provides no statistical evidence for a systematic change in the default risk of treated firms that experience an increase in liquidity after the ETS. These findings remain robust when alternative measures of liquidity are considered.

Our findings contribute to the literature by shedding light on the implications of financing responses to the ETS. In section 4, we provide robust evidence that the ETS incentivizes firms to expand their financial bases. Building on this, our analysis in this

Table 15: The Effects of the ETS on the Financing Response, Liquidity, and Default Risk

| **Panel A: Financial Leverage and Liquidity** | | | |
|---|---|---|---|
| Dependent Variable | *Current Ratio* | *Quick Ratio* | *Cash Ratio* |
| | (1) | (2) | (3) |
| *ETS* × *Post* × *LR Up* | -1.909*** | -1.740*** | -1.277*** |
| | (0.000) | (0.000) | (0.001) |
| *ETS* × *Post* × *LR Down* | 0.557* | 0.476 | 0.188 |
| | (0.089) | (0.122) | (0.627) |
| Firm FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes |
| Observations | 15,522 | 15,522 | 15,522 |
| Adjusted $R^2$ | 0.499 | 0.521 | 0.459 |
| p-value | 0.000 | 0.000 | 0.006 |
| **Panel B: Liquidity and Default Risk** | | | |
| Dependent Variable | *Distance-to-Default* | | |
| | Current Ratio | Quick Ratio | Cash Ratio |
| | (1) | (2) | (3) |
| *ETS* × *Post* × *Liquid Down* | -0.309*** | -0.263*** | -0.255*** |
| | (0.001) | (0.001) | (0.000) |
| *ETS* × *Post* × *Liquid Up* | 0.115 | 0.042 | 0.065 |
| | (0.170) | (0.696) | (0.616) |
| Firm FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes |
| Observations | 15,522 | 15,522 | 15,522 |
| Adjusted $R^2$ | 0.627 | 0.626 | 0.626 |
| p-value | 0.000 | 0.019 | 0.029 |

Note: The dependent variables are current ratio, quick Ratio, and cash ratio in columns (1)-(3) of Panel A. In Panel B, the dependent variables are *DtD*. *LR Up* is a dummy variable for a firm with its average leverage ratio higher in the pre-policy period than the ratio in the post-policy period. *LR Down* is a dummy variable for a firm with its average leverage ratio not higher in the pre-policy period than the ratio in the post-policy period. *Liquid Down* is a dummy variable, which equals one if the average liquidity ratio of a firm did not increase after 2014, and zero otherwise. *Liquid Up* is a dummy variable, which equals one if the average liquidity ratio of a firm increased after 2014, and zero otherwise. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

section reveals that firms with more aggressive financial structures experience a decrease in liquidity post-ETS, which subsequently exposes them to higher default risk. Importantly, these effects are not observed among low-polluting firms, suggesting that they are likely driven by the ETS. Prior studies argue that climate risk incentivizes firms to reduce their financial leverage, as this type of risk tends to amplify financial distress risk (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023). Our study extends this literature by demonstrating that a market-based environmental policy, such as the ETS, can increase default risk, primarily due to firms expanding their financial bases for investing activities rather than operating activities.

In summary, our research provides empirical evidence that the financing responses to the ETS have significant financial consequences. It induces firms to increase their financial leverage, which in turn decreases liquidity and raises default risk. These effects are distinct from the behavior of low-polluting firms. By highlighting the specific mechanisms through which the ETS impacts corporate financial decisions and risks, our study contributes to a better understanding of the implications of market-based environmental policies.

# 8 Conclusion

In this paper, we study the impact of China's ETS to gain insights into corporate responses to market-based environmental policy. Our findings uncover notable distinctions in financing, investment, and operational responses between the ETS and other climate risks that have been documented in the literature (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023; Wei et al., 2024; Yip et al., 2024). For example, we contribute to the literature on the relationship between climate risk and financial structure (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023; Wei et al., 2024; Yip et al., 2024). First, a majority of this literature indicates that firms tend to decrease their financial leverage in response to climate risk. However, we find the opposite: firms tend to adopt a more aggressive financial structure after the implementation of the ETS.

Second, several studies argue that climate risk increases the operating leverage and firms respond to the heightened operating leverage by decreasing their financial leverage

(Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023). Yip et al. (2024) further indicate that financially constrained firms tend to adopt a more conservative financial structure. With insufficient capital, these firms fail to re-optimize their input combinations, leaving the asset tangibility and labor demand nearly unaffected. As a result, climate policy can decrease the corporate productivity, profit, and survival rate of financially constrained firms. Contrary to this literature, we find no evidence of systematic change in operating leverage after the ETS. Instead, we provide robust evidence that the ETS stimulates innovation and enhances productivity.

Interestingly, we discover strong evidence that the innovation and productivity gains are concentrated among financially constrained, high-polluting firms. This surprising result is related to the literature on the real effect of financial constraints on innovation and productivity (Campello et al., 2010; Dang et al., 2022). We explore the underlying reason for the heterogeneity and the source of financing. Our findings indicate that financially constrained, high-polluting firms tend to have lower productivity levels prior to the implementation of the ETS. This helps to explain why the ETS provides these firms with a stronger incentive to engage in innovation and keep pace with industry advancements.

To finance their innovation expenses, these firms are found to adopt a more aggressive financial structure. Interestingly, we observe no systematic changes in their bank loans or bond debt, likely due to their financial constraints. Instead, they increase their financial leverage through NIBCL. Moreover, we find robust evidence that these firms actively seek alternative financial resources to support their innovation efforts. They tend to increase their trade credit, adopt a more conservative dividend policy, and engage in more tax avoidance. They also support the pecking order theory (Myers and Majluf, 1984; Graham and Harvey, 2001; Hovakimian et al., 2001; Leary and Roberts, 2005) in that firms prefer internal financing from retained earnings to external financing such as bank loans or bond debt. Our findings are consistent with the notion that trade finance, retained earnings, and corporate tax can provide liquidity insurance when bank credit is scarce (Garcia-Appendini and Montoriol-Garriga, 2013). Consequently, their liquidity decreases post-ETS, thereby elevating their default risk.

The significant difference in the financing, investment, and operational responses between ETS and other climate risks can be explained by a narrow version of the Porter Hypothesis (Porter, 1991; Jaffe and Palmer, 1997). This hypothesis posits that environmental policy can stimulate innovation when the policy instrument is stringent and flexible, such as market-based environmental policy (Jaffe and Palmer, 1997). While the majority of the literature focuses on non-market-based environmental policy and supports the compliance cost hypothesis (Nguyen and Phan, 2020; Dang et al., 2022; Ginglinger and Moreau, 2023; Yip et al., 2024), our paper extends the literature by demonstrating that the financing and investment responses to a market-based environmental policy, such as the ETS, can differ significantly.

By shedding light on the specific mechanisms through which financially constrained, high-polluting firms respond to market-based environmental policies, our research provides valuable insights for policymakers, industry practitioners, and researchers. Understanding these dynamics can aid in the design and implementation of effective environmental regulations that encourage innovation, enhance productivity, and promote sustainable development within the corporate sector.

Overall, our study advances the current understanding of the impact of market-based environmental policies and highlights the critical role that financial constraints play in shaping the responses of firms operating in high-pollution industries.

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# Appendix A

Table A1: Variable Definition

| Variable | Definition |
|---|---|
| **Financial Leverage** | |
| *Liability/BA* | The ratio of total liabilities to the book value of assets. |
| *Liability/MA* | The ratio of total liabilities to the market value of assets. |
| **Treatment Variables** | |
| *ETS* | It equals one if the industry of a firm in 2013 is covered by the ETS pilot program, and zero otherwise. |
| *Post* | It equals one if the sample year is in or after 2014, and zero otherwise. |
| **Control Variables** | |
| *Log(Assets)* | The natural logarithm of one plus book assets. |
| *PP&E* | The ratio of net property, plant, and equipment to the book value of assets. |
| *Market-to-Book* | The market-to-book ratio. |
| *EBIT* | The ratio of earnings before interest and taxes to the book value of assets. |
| *Advertising* | The ratio of advertising expenses to the book value of assets. |
| *Log(Employees)* | The natural logarithm of one plus the number of employees. |
| *Depreciation* | The ratio of depreciation to the book value of assets. |
| *Firm FE* | Firm fixed effects. |
| *Year FE* | Year fixed effects. |

Table A1: Variable Definition (Cont.)

| Variable | Definition |
|---|---|
| *Liability/BE* | The ratio of total liabilities to the book value of net assets. |
| *Liability/ME* | The ratio of total liabilities to the market value of net assets. |
| *KLNOL* | The sensitivity of innovations in the growth rate of operating costs to the innovations in the growth rate of sales. |
| *NMOL* | The ratio of the cost of goods sold and selling, general, and administrative expenses to total assets. |
| *NCFOA/BA* | The ratio of net cash flow from operating activities to total assets. |
| *Sales/BA* | The ratio of sales revenue activities to total assets. |
| *COGS/BA* | The ratio of cost of goods sold to total assets. |
| $ln(TFP_{LP})$ | The natural logarithm of total factor productivity (See Levinsohn and Petrin (2003)). |
| $ln(TFP_{OP})$ | The natural logarithm of total factor productivity (See Olley and Pakes (1996)). |
| *Tech. Efficiency* | Technology efficiency (See Wang and Ho (2010)). |
| $CoD_1$ | The ratio of financial expenses to total debts. |
| $CoD_2$ | The ratio of financial expenses to the mean value of total debts in year t-1 and t. |
| *Debt Ratio* | The ratio of total debt to total assets. Total debt includes short-term borrowings, interest payable, long-term liabilities due within one year, long-term loans, bonds payable, and long-term payables. |
| *Bank Loan Ratio* | The ratio of long-term loans to total assets. |
| Bond Ratio | The ratio of bonds payable to total assets. |
| *NIBL/BA* | The ratio of NIBL to total assets. |
| *NIBCL/BA* | The ratio of NIBL liabilities in the short-term to total assets. |
| *NIBNCL/BA* | The ratio of NIBL in the long-term to total assets. |
| *TC* | The ratio of accounts payable, notes payable, and advanced payments to total assets. |
| *DPR* | The ratio of total pre-tax cash dividends to net income. |
| *DETR* | Income tax expense divided by pretax income, and then minus the applicable statutory tax rate. |
| *Current Ratio* | A firm's total current assets divided by its total current liabilities. |
| *Quick Ratio* | A firm's current assets less its current liabilities divided by its total current liabilities. |
| *Cash Ratio* | A firm's cash and cash equivalents divided by its total current liabilities. |
| *DtD* | Distance-to-default value calculated using KMV model. |
| *CAA* | The natural logarithm of the provincial reduction target under China's Clean Air Acts. |
| *WW* | The WW index (See Whited and Wu (2006)). |
| *Payout* | Total cash dividends before tax divided by net income. |
| *Size* | The natural logarithm of one plus book assets. |
| *HP* | The HP index (See Hadlock and Pierce (2010)). |
| *KZ* | The KZ index (See Kaplan and Zingales (1997)). |
| *Composite* | See Bartram et al. (2022). |
| *ERS* | The firm's environmental responsibility score evaluated by HEXUN platform. |
| *SOE* | Firms ownership status. It equals one if firms are owned by the state, and zero otherwise. |

Table A2: Region, Launch Date, and Industry Covered by ETS

| **Region** | **Launch Date** | **Industry** |
|---|---|---|
| Beijing | Nov. 28, 2013 | Steel, cement, chemical and other industries<br>All industries except A4, B11, E48, E49, & E50 |
| Chongqing | June 19, 2014 | Chemical industry, metallurgy, electric power, building materials, machinery, light industry, etc.<br>C22, C26, C30, C31, C32, C33, & D44 |
| Guangdong | Dec. 19, 2013 | Steel, cement, chemical industry, etc.<br>C25, C30, C31, C33, & D44 |
| Hubei | Apr. 02, 2014 | Steel, cement, chemical industry, etc.<br>C14, C22, C25, C26, C27, C28, C30, C31, C33, C34, C35, C36, D44, & D45 |
| Shanghai | Nov. 26, 2013 | Steel, Petrochemical, chemical industry, electricity, heat and other industries<br>C17, C22, C25, C26, C28, C29, C30, C31, C32, C33, D44, G53, G55, G56, & H61 |
| Shenzhen | June 18, 2013 | Industrial sector<br>D44, D45, D46, C, E47, E48, G53, G54, G55, & G56 |
| Tianjin | Dec. 26, 2013 | Steel, Petrochemical, chemical industry, electricity, heat and other industries<br>B07, C25, C26, C30, C31, C33, & D44 |

Note: The industry codes adhere to the of National Economy Industries" for standardized reporting.

Table A3: Descriptive Statistics

| **Variables** | **N** | **Mean** | **P25** | **Median** | **P75** | **Standard Deviation** |
|---|---|---|---|---|---|---|
| *Liability/BE* | 15,755 | 1.223 | 0.385 | 0.801 | 1.583 | 1.308 |
| *Liability/ME* | 15,755 | 0.673 | 0.142 | 0.332 | 0.78 | 0.933 |
| *KLNOL* | 14,958 | 0.038 | -0.006 | 0.009 | 0.039 | 0.117 |
| *NMOL* | 15,755 | 0.575 | 0.286 | 0.466 | 0.72 | 0.436 |
| *NCFOA/BA* | 15,755 | 0.043 | 0.002 | 0.042 | 0.086 | 0.082 |
| *Sales/BA* | 15,755 | 0.629 | 0.334 | 0.525 | 0.785 | 0.444 |
| *COGS/BA* | 15,755 | 0.488 | 0.21 | 0.379 | 0.614 | 0.417 |
| *RD/Sales* | 15,754 | 0.014 | 0 | 0 | 0.021 | 0.027 |
| $ln(TFP_{LP})$ | 15,106 | 8.244 | 7.519 | 8.15 | 8.869 | 1.05 |
| $ln(TFP_{OP})$ | 15,106 | 2.016 | 1.936 | 2.009 | 2.093 | 0.117 |
| *Tech. Efficiency* | 15,732 | 0.646 | 0.535 | 0.695 | 0.796 | 0.195 |
| $CoD_1$ | 15,755 | -0.002 | -0.003 | 0.021 | 0.04 | 0.096 |
| $CoD_2$ | 15,755 | -0.002 | -0.003 | 0.023 | 0.042 | 0.097 |
| *Debt Ratio* | 15,755 | 0.198 | 0.042 | 0.172 | 0.317 | 0.17 |
| *Bank Loan Ratio* | 15,755 | 0.157 | 0.026 | 0.131 | 0.252 | 0.143 |
| *Bond Ratio* | 15,755 | 0.016 | 0 | 0 | 0 | 0.04 |
| *NIBL/BA* | 15,755 | 0.247 | 0.139 | 0.216 | 0.324 | 0.143 |
| *NIBCL/BA* | 15,755 | 0.23 | 0.124 | 0.198 | 0.306 | 0.142 |
| *NIBNCL/BA* | 15,755 | 0.016 | 0.002 | 0.008 | 0.021 | 0.023 |
| *TC* | 15,755 | 0.164 | 0.073 | 0.134 | 0.227 | 0.122 |
| *DPR* | 11,009 | 0.37 | 0.173 | 0.29 | 0.437 | 0.339 |
| *DETR* | 13,854 | -0.007 | -0.036 | 0.001 | 0.045 | 0.134 |
| *Current Ratio* | 15,755 | 2.518 | 1.062 | 1.553 | 2.508 | 4.482 |
| *Quick Ratio* | 15,755 | 1.972 | 0.643 | 1.064 | 1.915 | 4.05 |
| *Cash Ratio* | 15,755 | 1.012 | 0.187 | 0.374 | 0.846 | 3.017 |
| *DtD* | 15,755 | 0.915 | 0.711 | 1.285 | 1.823 | 1.739 |
| *CAA* | 15,755 | 2.631 | 2.303 | 2.708 | 2.996 | 0.614 |

Note: This table reports summary statistics. Table A1 presents variable definitions.

# Online Appendix

Table OA1: Comparison of Firm Characteristics for the PSM, EB, and CEM Samples

Panel A: Propensity Score Matched Sample

| | Untreated Firms (Obs.=2,619) | Treated Firms (Obs.=2,619) | Mean Difference | p-value |
|---|---|---|---|---|
| Propensity Score | 0.174 | 0.174 | 0.000 | 0.989 |
| *Log(Assets)* | 22.117 | 22.123 | -0.007 | 0.863 |
| *PP&E* | 0.220 | 0.224 | -0.004 | 0.389 |
| *Market-to-Book* | 1.535 | 1.545 | 0.010 | 0.820 |
| *EBIT* | 0.063 | 0.063 | 0.000 | 0.745 |

Panel B: Entropy Balanced Sample

| | Untreated Firms (Obs.=13,136) | | Treated Firms (Obs.=2,619) | | Difference in | Difference in |
|---|---|---|---|---|---|---|
| | Mean | Variance | Mean | Variance | Mean | Variance |
| *Log(Assets)* | 22.123 | 2.125 | 22.123 | 2.125 | 0.000 | -0.001 |
| *PP&E* | 0.225 | 0.034 | 0.224 | 0.034 | 0.000 | 0.000 |
| *Market-to-Book* | 1.544 | 2.137 | 1.545 | 2.137 | 0.000 | 0.001 |
| *EBIT* | 0.063 | 0.003 | 0.063 | 0.003 | 0.000 | 0.000 |

Panel C: Coarsened Exact Matching Sample

| | Untreated Firms (Obs.=3,559) | Treated Firms (Obs.=1,525) | Mean Difference | p-value |
|---|---|---|---|---|
| *Log(Assets)* | 21.900 | 21.921 | -0.021 | 0.580 |
| *PP&E* | 0.181 | 0.180 | 0.001 | 0.836 |
| *Market-to-Book* | 1.144 | 1.205 | -0.061 | 0.053 |
| *EBIT* | 0.058 | 0.058 | 0.001 | 0.510 |

Note: Panel A tabulates the means of the propensity scores and the firm-level control variables across the treated and untreated groups in the propensity score matched sample. Panel B tabulates the mean and variance of firm characteristics for the treated and untreated groups of the entropy balanced sample. Panel C tabulates the mean of firm characteristics for the treated and untreated groups of the CEM sample. See Table A1 for variable definitions.

Table OA2: Additional Entropy Balancing Analyses

Panel A: Entropy Balanced Sample (First Moment)

| | Untreated Firms (Obs.=13,136) | Treated Firms (Obs.=2,619) | Mean Difference |
|---|---|---|---|
| *Log(Assets)* | 22.123 | 22.123 | -0.001 |
| *PP&E* | 0.225 | 0.224 | 0.000 |
| *Market-to-Book* | 1.544 | 1.545 | 0.000 |
| *EBIT* | 0.063 | 0.063 | 0.000 |

Panel B: Entropy Balanced Sample (Third Moment)

| | Untreated Firms (Obs.=13,136) | | | Treated Firms (Obs.=2,619) | | |
|---|---|---|---|---|---|---|
| | Mean | Variance | Skewness | Mean | Variance | Skewness |
| *Log(Assets)* | 22.123 | 2.124 | 0.748 | 22.123 | 2.125 | 0.747 |
| *PP&E* | 0.225 | 0.034 | 0.943 | 0.224 | 0.034 | 0.944 |
| *Market-to-Book* | 1.544 | 2.137 | 2.420 | 1.545 | 2.137 | 2.419 |
| *EBIT* | 0.063 | 0.003 | 0.261 | 0.063 | 0.003 | 0.260 |

Panel C: Entropy Balancing Analyses

| | Entropy Balancing on the First Moment | | Entropy Balancing on the Third Moment | |
|---|---|---|---|---|
| | *Liability/BA* | *Liability/MA* | *Liability/BA* | *Liability/MA* |
| | (1) | (2) | (3) | (4) |
| *ETS × Post* | 0.018*** | 0.076*** | 0.017*** | 0.068*** |
| | (0.004) | (0.003) | (0.009) | (0.010) |
| *Log(Assets)* | 0.065*** | 0.293*** | 0.065*** | 0.294*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| *PP&E* | 0.082*** | -0.109 | 0.083*** | -0.109 |
| | (0.002) | (0.174) | (0.002) | (0.173) |
| *Market-to-Book* | 0.007*** | 0.007 | 0.007*** | 0.010* |
| | (0.000) | (0.192) | (0.000) | (0.077) |
| *EBIT* | -0.420*** | -1.110*** | -0.416*** | -1.128*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Observations | 15,755 | 15,755 | 15,755 | 15,755 |
| Adjusted $R^2$ | 0.833 | 0.765 | 0.833 | 0.775 |

Note: Panels A and B tabulate the mean, variance, and skewness of firm characteristics for the treated and untreated groups of the entropy-balanced samples using entropy balancing on the first and third moment. Panel C reports the estimate from equation (1). Standard errors clustered at the firm level are reported in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for variable definitions.

Table OA3: The Effect of the ETS on Financial Leverage (Alternative Measures)

| | *Liability/BE* | | | *Liability/ME* | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.075 | 0.090 | 0.091 | 0.062 | 0.066 | 0.067 |
| | (0.087)* | (0.032)** | (0.030)** | (0.090)* | (0.055)* | (0.052)* |
| | [0.024]** | [0.005]*** | [0.004]*** | [0.022]** | [0.002]*** | [0.001]*** |
| | {0.000}*** | {0.000}*** | {0.000}*** | {0.036}** | {0.000}*** | {0.001}*** |
| *Log(Assets)* | | 0.339*** | 0.336*** | | 0.351*** | 0.370*** |
| | | (0.000) | (0.000) | | (0.000) | (0.000) |
| *PP&E* | | 0.202 | 0.313* | | -0.101 | 0.096 |
| | | (0.101) | (0.065) | | (0.206) | (0.357) |
| *Market-to-Book* | | 0.020** | 0.020** | | -0.005 | -0.004 |
| | | (0.021) | (0.020) | | (0.341) | (0.388) |
| *EBIT* | | -2.868*** | -2.90*** | | -1.006*** | -1.043*** |
| | | (0.000) | (0.000) | | (0.000) | (0.000) |
| *Advertising* | | | 0.432 | | | 0.490* |
| | | | (0.408) | | | (0.065) |
| *Log(Employees)* | | | 0.004 | | | -0.041** |
| | | | (0.875) | | | (0.041) |
| *Depreciation* | | | -2.260 | | | -3.250*** |
| | | | (0.329) | | | (0.009) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,755 | 15,755 | 15,710 | 15,755 | 15,755 | 15,710 |
| Adjusted $R^2$ | 0.733 | 0.746 | 0.746 | 0.716 | 0.733 | 0.734 |

Note: The average *Liability/BE* and *Liability/ME* are 1.223 and 0.673. Standard errors are clustered at the levels of firm and province in round and square brackets. Two-way cluster-robust standard errors across provinces and industries in curly brackets. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

Table OA4: The Effects of the ETS Estimated using Three Matching Methods (Alternative Measures)

| | *Liability/BE* | | | *Liability/ME* | | |
|---|---|---|---|---|---|---|
| | PSM | EB | CEM | PSM | EB | CEM |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.161*** | 0.093** | 0.104* | 0.139*** | 0.080** | 0.083* |
| | (0.008) | (0.032) | (0.075) | (0.002) | (0.027) | (0.072) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 5,238 | 15,755 | 5,084 | 5,238 | 15,755 | 5,084 |
| Adjusted $R^2$ | 0.778 | 0.766 | 0.849 | 0.753 | 0.761 | 0.806 |

Note: Standard errors clustered at the firm level are reported in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

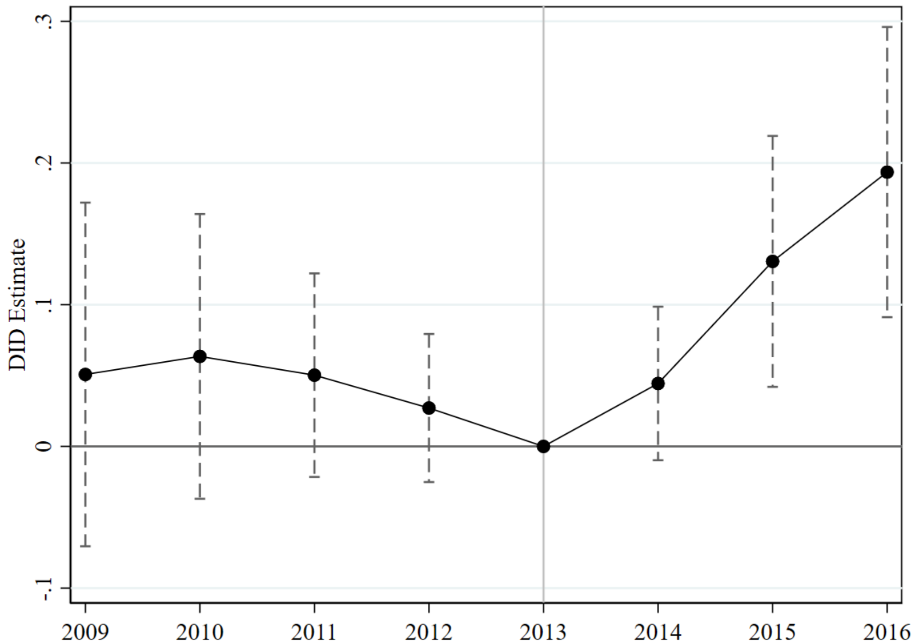
Table OA5: Additional Entropy Balancing Analyses (Alternative Measures)

| | Entropy Balancing on the First Moment | | Entropy Balancing on the Third Moment | |
|---|---|---|---|---|
| | *Liability/BE* | *Liability/ME* | *Liability/BE* | *Liability/ME* |
| | (1) | (2) | (3) | (4) |
| *ETS* × *Post* | 0.092** | 0.081** | 0.095** | 0.070* |
| | (0.033) | (0.020) | (0.028) | (0.051) |
| *Log(Assets)* | 0.328*** | 0.360*** | 0.324*** | 0.360*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| *PP&E* | 0.016 | -0.189* | 0.003 | -0.183* |
| | (0.924) | (0.073) | (0.986) | (0.078) |
| *Market-to-Book* | 0.011 | -0.007 | 0.013 | -0.006 |
| | (0.269) | (0.325) | (0.189) | (0.463) |
| *EBIT* | -2.855*** | -1.226*** | -2.872*** | -1.245*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Firm FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes |
| Observations | 15,755 | 15,755 | 15,755 | 15,755 |
| Adjusted $R^2$ | 0.757 | 0.747 | 0.760 | 0.760 |

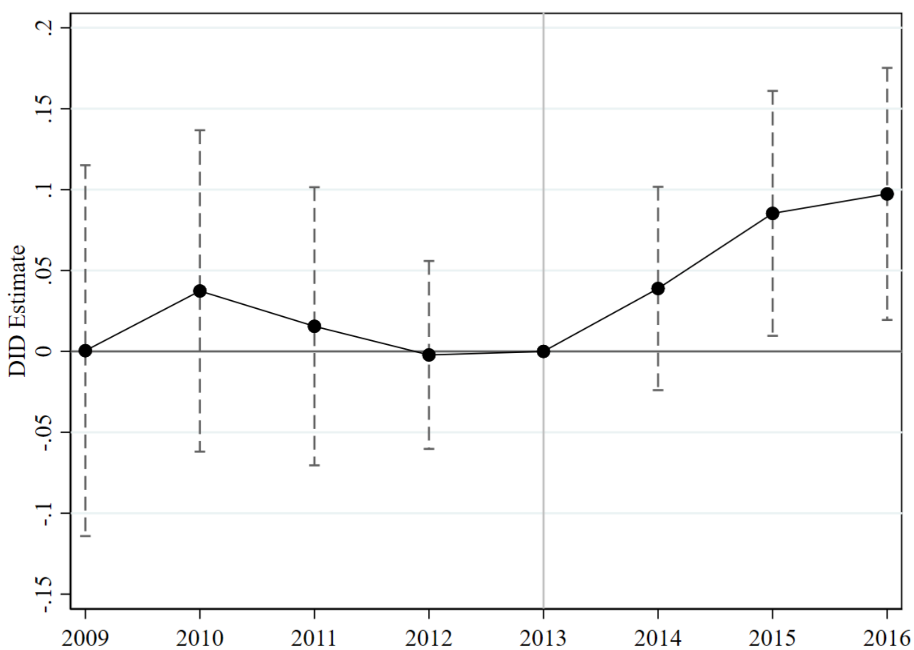
Note: Standard errors clustered at the firm level are reported in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for variable definitions.

Figure OA1: The Dynamics of the Leverage Responses (Alternative Measures)

**Panel A: *Liability/BE***



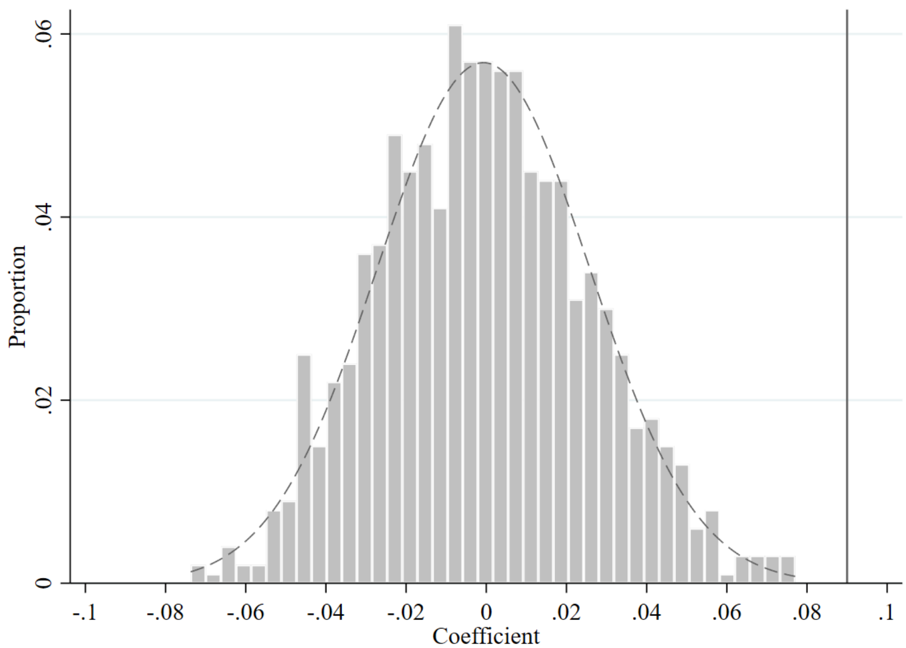

**Panel B: *Liability/ME***



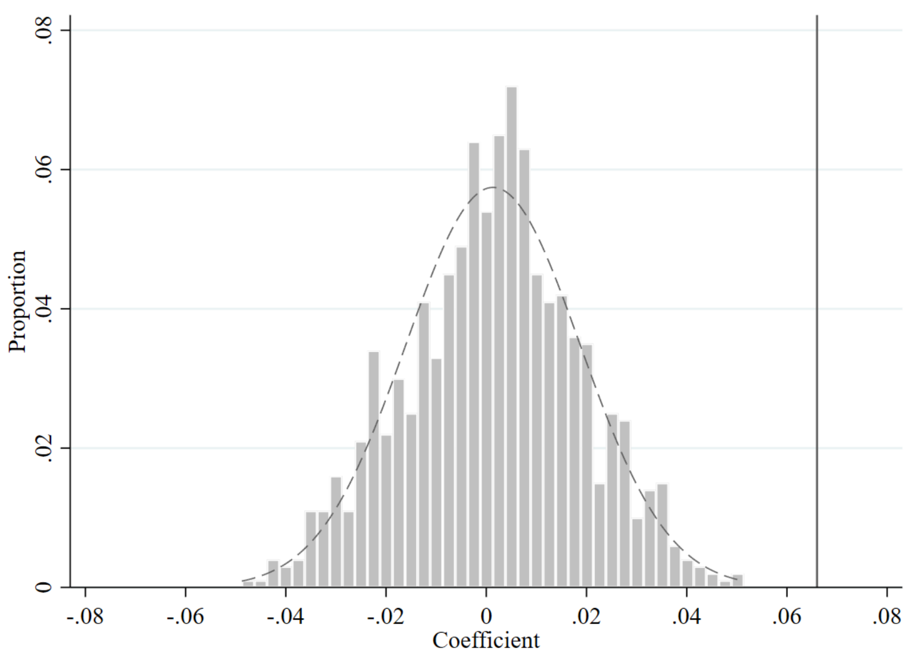

Note: The dependent variables are *Liability/BE* and *Liability/ME* in Panels A and B. Robust-standard errors are clustered at the firm level. The vertical dashed line represents the reference year. The vertical solid line represents a 95 percent confidence interval.

Figure OA2: The Distribution of the Estimated Coefficients of the Placebo Tests (Alternative Measures)

**Panel A: *Liability/BE***




**Panel B: *Liability/ME***




Note: The figures show the distribution density of the estimated coefficients of the placebo tests from 1,000 simulations. The dependent variables are *Liability/BE* and *Liability/ME* in Panels A and B. The vertical lines illustrate the estimated coefficient using the true assignments of treatment.

Table OA6: Reduction Target of China's CAA

| **Reduction Targets of PM2.5 (PM10)** | **Provinces** |
|---|---|
| 25% | Beijing, Hebei, Tianjin |
| 20% | Jiangsu, Shandong, Shanghai, Shanxi, Zhejiang |
| 15% | Chongqing, Guangdong, Henan, Qinghai, Shaanxi, Xinjiang |
| (12%) | Gansu, Hubei |
| 10% | Anhui, Hunan, Inner Mongolia, Jilin, Liaoning, Ningxia, Sichuan |
| 5% | Fujian, Guangxi, Guizhou, Heilongjiang, Jiangxi |
| 0% | Hainan, Tibet, Yunnan |

Source: Air Pollution Prevention and Control Action Plan, issued by the State Council of China in September 2013.

Table OA7: The Effect of the ETS on Financial Leverage (Confounding Factor)

| | *Liability/BA* | | | *Liability/MA* | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.015 | 0.016 | 0.017 | 0.064 | 0.067 | 0.067 |
| | (0.031)** | (0.013)** | (0.010)** | (0.021)** | (0.010)*** | (0.009)*** |
| | [0.044]** | [0.008]*** | [0.006]*** | [0.018]** | [0.002]*** | [0.002]*** |
| | {0.000}*** | {0.000}*** | {0.000}*** | {0.052}* | {0.007}*** | {0.007}*** |
| *CAA* × *Post* | 0.001 | 0.001 | -0.000 | -0.018 | -0.018 | -0.018 |
| | (0.767) | (0.825) | (0.993) | (0.334) | (0.307) | (0.307) |
| *Log(Assets)* | | 0.067*** | 0.062*** | | 0.288*** | 0.296*** |
| | | (0.000) | (0.000) | | (0.000) | (0.000) |
| *PP&E* | | 0.099*** | 0.101*** | | -0.057 | 0.102 |
| | | (0.000) | (0.000) | | (0.343) | (0.197) |
| *Market-to-Book* | | 0.008*** | 0.008*** | | 0.007* | 0.008** |
| | | (0.000) | (0.000) | | (0.063) | (0.045) |
| *EBIT* | | -0.420*** | -0.427*** | | -0.919*** | -0.953*** |
| | | (0.000) | (0.000) | | (0.000) | (0.000) |
| *Advertising* | | | 0.140* | | | 0.372** |
| | | | (0.089) | | | (0.048) |
| *Log(Employees)* | | | 0.009** | | | -0.023 |
| | | | (0.012) | | | (0.125) |
| *Depreciation* | | | -0.227 | | | -2.799*** |
| | | | (0.384) | | | (0.003) |
| Observations | 15,755 | 15,755 | 15,710 | 15,755 | 15,755 | 15,710 |
| Adjusted $R^2$ | 0.809 | 0.825 | 0.825 | 0.731 | 0.748 | 0.749 |

Note: The average *Liability/BA* and *Liability/MA* are 44.6% and 60.1%. *CAA* is the natural logarithm of the provincial reduction target under China's Clean Air Acts. Standard errors are clustered at the levels of firm and province in round and square brackets. Two-way cluster-robust standard errors across provinces and industries in curly brackets. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

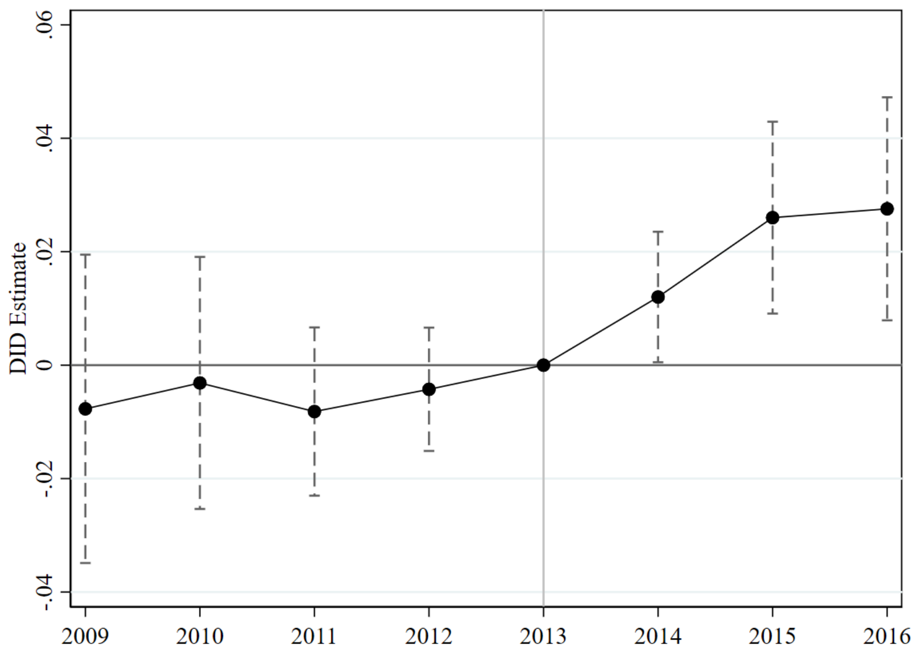
Table OA8: The Effect of the ETS on Financial Leverage (Alternative Measures & Confounding Factor)

| | *Liability/BE* | | | *Liability/ME* | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.08 | 0.094 | 0.097 | 0.071 | 0.075 | 0.076 |
| | (0.082)* | (0.032)** | (0.028)** | (0.058)* | (0.033)** | (0.032)** |
| | (0.021)** | (0.003)*** | (0.002)*** | (0.041)** | (0.008)*** | (0.007)*** |
| | (0.000)*** | (0.000)*** | (0.000)*** | (0.076)* | (0.013)** | (0.011)** |
| *CAA* × *Post* | -0.013 | -0.012 | -0.014 | -0.025 | -0.025 | -0.024 |
| | (0.736) | (0.749) | (0.704) | (0.321) | (0.308) | (0.321) |
| *Log(Assets)* | | 0.339*** | 0.332*** | | 0.351*** | 0.370*** |
| | | (0.000) | (0.000) | | (0.000) | (0.000) |
| *PP&E* | | 0.202 | 0.316* | | -0.101 | 0.096 |
| | | (0.100) | (0.062) | | (0.209) | (0.356) |
| *Market-to-Book* | | 0.020** | 0.020** | | -0.004 | -0.004 |
| | | (0.021) | (0.020) | | (0.362) | (0.408) |
| *EBIT* | | -2.867*** | -2.903*** | | -1.004*** | -1.042*** |
| | | (0.000) | (0.000) | | (0.000) | (0.000) |
| *Advertising* | | | 0.439 | | | 0.501* |
| | | | (0.402) | | | (0.060) |
| *Log(Employees)* | | | 0.005 | | | -0.041** |
| | | | (0.863) | | | (0.044) |
| *Depreciation* | | | -2.262 | | | -3.254*** |
| | | | (0.328) | | | (0.009) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,755 | 15,755 | 15,710 | 15,755 | 15,755 | 15,710 |
| Adjusted $R^2$ | 0.733 | 0.746 | 0.746 | 0.716 | 0.733 | 0.734 |

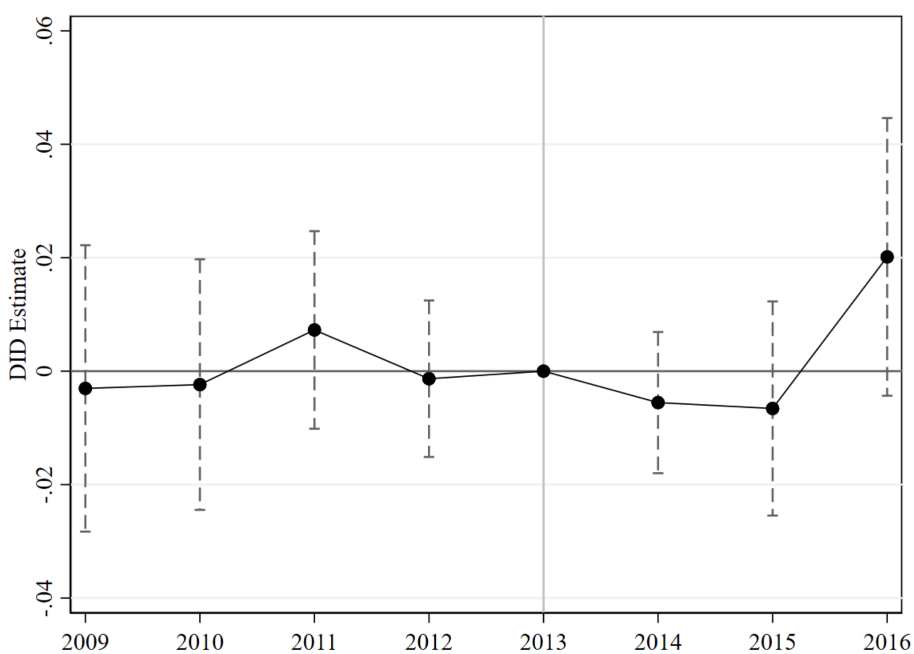
Note: The average *Liability/BE* and *Liability/ME* are 1.223 and 0.673. *CAA* is the natural logarithm of the provincial reduction target under China's Clean Air Acts. Standard errors are clustered at the levels of firm and province in round and square brackets. Two-way cluster-robust standard errors across provinces and industries in curly brackets. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

Figure OA3: Corporate Environmental Performances and the Dynamics of the Leverage Responses

**Panel A: *High-Polluting Firms***



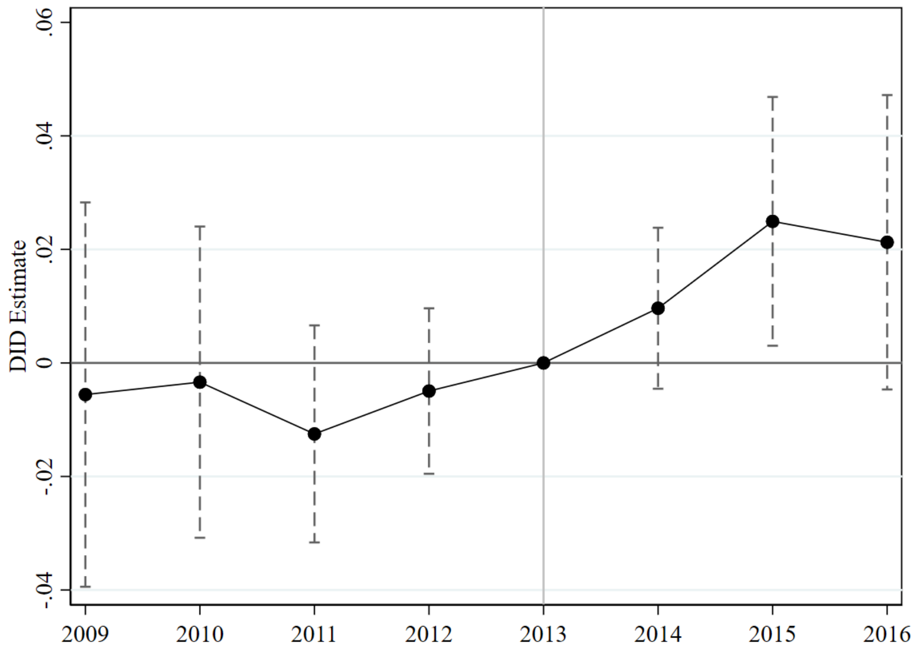

**Panel B: *Low-Polluting Firms***



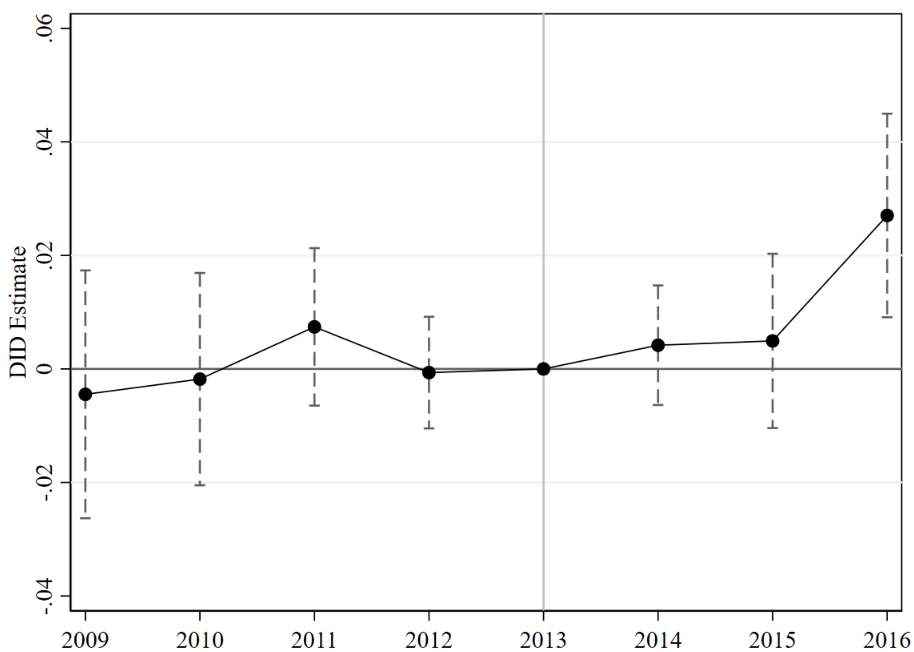

Note: The dependent variable is *Liability/BA*. Samples are restricted to high- and low-polluting firms in Panels A and B. Standard errors are clustered at the firm level in parentheses. The vertical grey line represents the reference year. The vertical dashed line represents a 95 percent confidence interval.

Figure OA4: Financial Constraints and the Dynamics of the Leverage Responses

**Panel A:** ***Financially Constrained Firms***



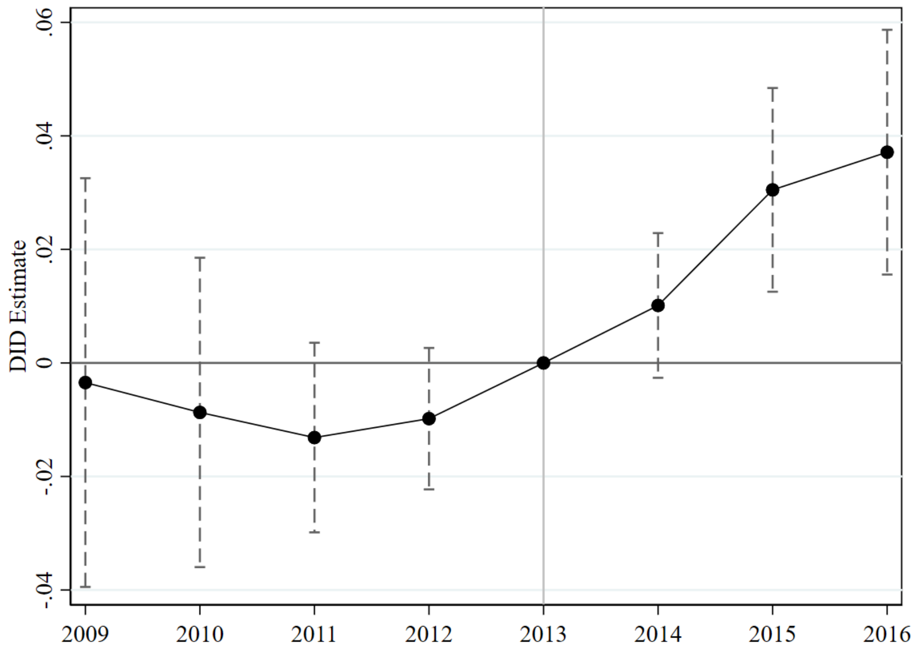

**Panel B:** ***Financially Unconstrained Firms***



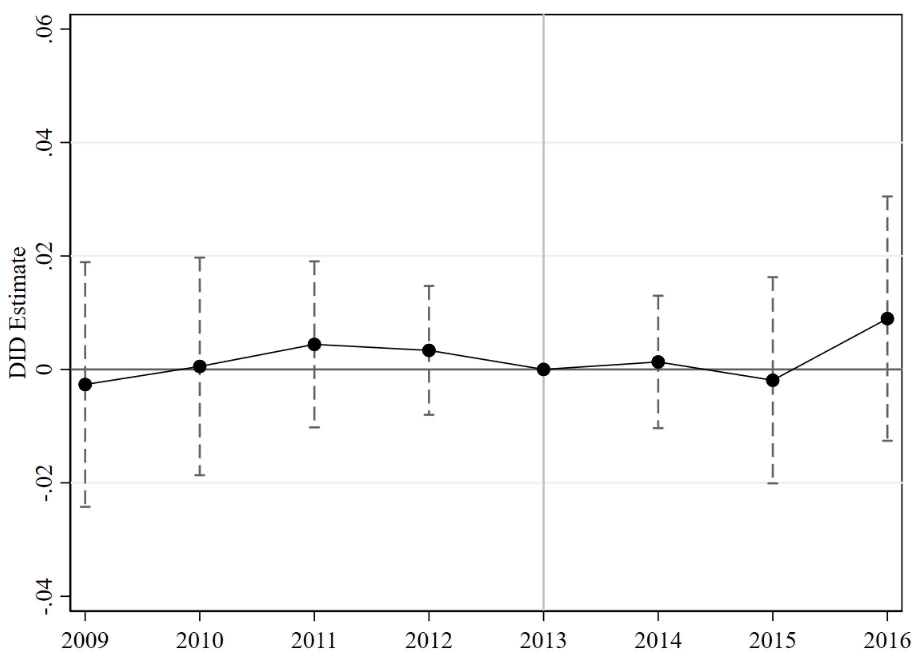

Note: The dependent variable is *Liability/BA*. Samples are restricted to financially constrained and unconstrained firms in Panels A and B. Standard errors are clustered at the firm level in parentheses. The vertical grey line represents the reference year. The vertical dashed line represents a 95 percent confidence interval.

Figure OA5: Ownership Structures and the Dynamics of the Leverage Responses

**Panel A:** ***Non-SOEs***



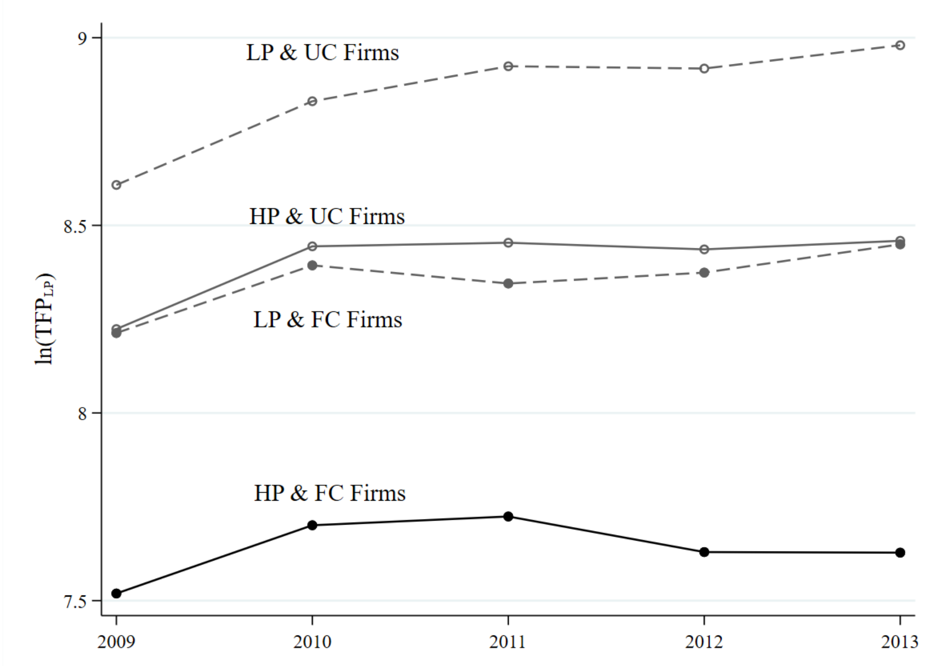

**Panel B:** ***SOEs***



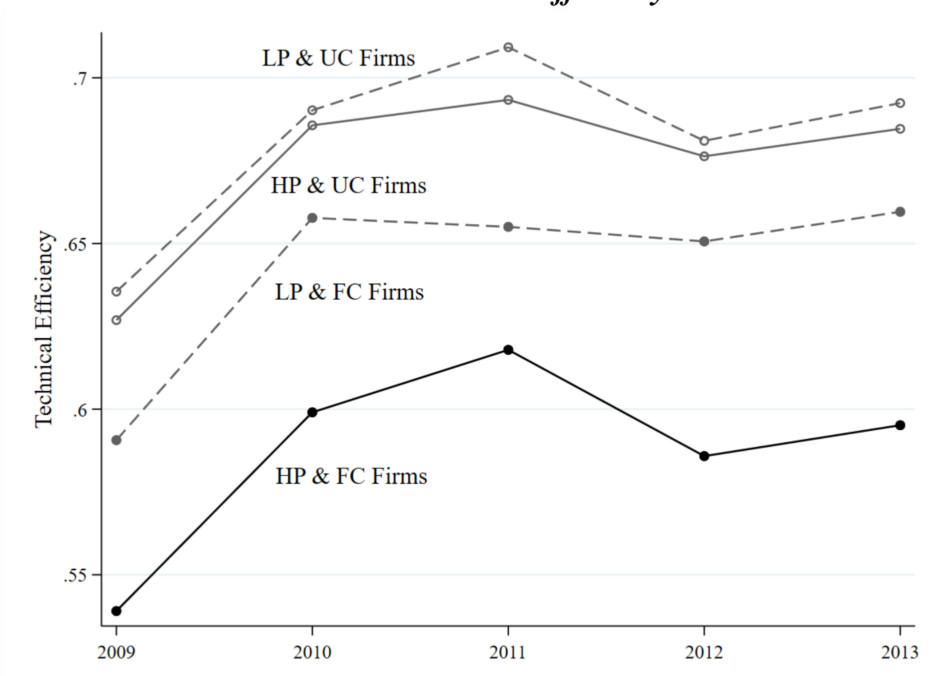

Note: The dependent variable is *Liability/BA*. Samples are restricted to non-SOEs and SOEs in Panels A and B. Standard errors are clustered at the firm level in parentheses. The vertical grey line represents the reference year. The vertical dashed line represents a 95 percent confidence interval.

Figure OA6: Productivity Dynamics 2009-2013 (TFP$_{LP}$ and Technical Efficiency)

**Panel A:** ln(***TFP***$_{LP}$)




**Panel B:** ***Technical Efficiency***




Note: We measure productivity by ln(*TFP*$_{LP}$) and *Tech. Efficiency*. *HP Firm* and *LP Firm* indicates high-polluting and low-polluting firms. *FC Firm* and *FU Firm* indicates firms with relatively tight and loose financial constraints.

Table OA9: ETS and $\text{TFP}_{LP}$

Panel A: The Effect of the ETS on $\text{TFP}_{LP}$

| | No Matching | | PSM | | EB | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS × Post* | 0.082*** | | 0.083** | | 0.078*** | |
| | (0.002) | | (0.021) | | (0.004) | |
| *ETS × Post × HP Firm* | | 0.138*** | | 0.141*** | | 0.134*** |
| | | (0.000) | | (0.001) | | (0.000) |
| *ETS × Post × LP Firm* | | -0.022 | | -0.024 | | -0.026 |
| | | (0.560) | | (0.599) | | (0.495) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,106 | 15,094 | 4,954 | 4,953 | 15,106 | 15,094 |
| Adjusted $R^2$ | 0.887 | 0.887 | 0.896 | 0.897 | 0.905 | 0.906 |
| p-value | — | 0.001 | — | 0.001 | — | 0.001 |

Panel B: The Heterogeneous Effects of ETS on $\text{TFP}_{LP}$

| | No Matching | | PSM | | EB | |
|---|---|---|---|---|---|---|
| | HP Firm | LP Firm | HP Firm | LP Firm | HP Firm | LP Firm |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS × Post × FC Firm* | 0.180*** | 0.035 | 0.172*** | 0.051 | 0.173*** | 0.030 |
| | (0.000) | (0.710) | (0.003) | (0.618) | (0.000) | (0.755) |
| *ETS × Post × FU Firm* | 0.057 | 0.008 | 0.045 | 0.022 | 0.050 | 0.001 |
| | (0.139) | (0.838) | (0.360) | (0.694) | (0.199) | (0.990) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 10,934 | 4,008 | 3,314 | 1,585 | 10,934 | 4,008 |
| Adjusted $R^2$ | 0.852 | 0.925 | 0.861 | 0.925 | 0.862 | 0.937 |
| p-value | 0.034 | 0.789 | 0.033 | 0.774 | 0.0371 | 0.771 |

Panel C: The Interplay between Financial and Investment Responses

| | No Matching | PSM | EB |
|---|---|---|---|
| | (1) | (2) | (3) |
| *ETS × Post × LR Up* | 0.150*** | 0.159*** | 0.147*** |
| | (0.000) | (0.000) | (0.000) |
| *ETS × Post × LR Down* | -0.031 | -0.024 | -0.037 |
| | (0.450) | (0.610) | (0.372) |
| Firm FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 14,886 | 4,887 | 14,886 |
| Adjusted $R^2$ | 0.887 | 0.905 | 0.908 |
| p-value | 0.000 | 0.000 | 0.000 |

Note: The dependent variables are $\ln(TFP_{IP})$. *HP Firm* (*LP Firm*) is a dummy variable for high-polluting (low-polluting) firms. *FC Firm* (*FU Firm*) is a dummy variable for financially constrained (unconstrained) firms. *LR Up* (*LR Down*) is a dummy variable for firms that increased (did not increase) their leverage ratio ex post. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

Table OA10: ETS, Innovation, and Productivity (PSM)

| Panel A: The Effects of ETS on R&D, TFP, and Technical Efficiency | | | | | | |
|---|---|---|---|---|---|---|
| | *RD/Sales* | | $\ln(TFP_{OP})$ | | *Tech. Efficiency* | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS × Post* | 0.005*** | | 0.011** | | 0.027* | |
| | (0.005) | | (0.033) | | (0.051) | |
| *ETS × Post × HP Firm* | | 0.007*** | | 0.020*** | | 0.051*** |
| | | (0.001) | | (0.001) | | (0.001) |
| *ETS × Post × LP Firm* | | 0.001 | | -0.005 | | -0.017 |
| | | (0.544) | | (0.422) | | (0.379) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 5,238 | 5,229 | 4,954 | 4,953 | 5,227 | 5,218 |
| Adjusted $R^2$ | 0.560 | 0.561 | 0.854 | 0.855 | 0.500 | 0.504 |
| p-value | — | 0.031 | — | 0.000 | — | 0.001 |
| **Panel B: The Heterogeneous Effects of ETS on R&D, TFP, and Technical Efficiency** | | | | | | |
| | *RD/Sales* | | $\ln(TFP_{OP})$ | | *Tech. Efficiency* | |
| | HP Firm | LP Firm | HP Firm | LP Firm | HP Firm | LP Firm |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS × Post × FC Firm* | 0.010*** | 0.007 | 0.029*** | 0.004 | 0.072*** | 0.015 |
| | (0.001) | (0.124) | (0.001) | (0.757) | (0.000) | (0.698) |
| *ETS × Post × FU Firm* | 0.002 | 0.001 | 0.006 | -0.004 | -0.008 | 0.011 |
| | (0.382) | (0.759) | (0.417) | (0.586) | (0.696) | (0.672) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 3,498 | 1,673 | 3,314 | 1,585 | 3,489 | 1,671 |
| Adjusted $R^2$ | 0.553 | 0.489 | 0.825 | 0.876 | 0.526 | 0.477 |
| p-value | 0.032 | 0.185 | 0.006 | 0.513 | 0.000 | 0.916 |

| Panel C: The Interplay between Financial and Investment Responses | | | |
|---|---|---|---|
| | *RD/Sales* | $\ln(TFP_{OP})$ | *Tech. Efficiency* |
| | (1) | (2) | (3) |
| *ETS × Post × LR Up* | 0.007*** | 0.023*** | 0.065*** |
| | (0.000) | (0.000) | (0.000) |
| *ETS × Post × LR Down* | -0.001 | -0.002 | 0.014 |
| | (0.569) | (0.731) | (0.427) |
| Firm FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 5,171 | 4,887 | 5,162 |
| Adjusted $R^2$ | 0.577 | 0.869 | 0.519 |
| p-value | 0.000 | 0.001 | 0.008 |

Note: *HP Firm* (*LP Firm*) is a dummy variable for high-polluting (low-polluting) firms. *FC Firm* (*FU Firm*) is a dummy variable for financially constrained (unconstrained) firms. *LR Up* (*LR Down*) is a dummy variable for firms that increased (did not increase) their leverage ratio ex post. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

Table OA11: ETS, Innovation, and Productivity (EB)

| Panel A: The Effects of ETS on R&D, TFP, and Technical Efficiency | | | | | | |
|---|---|---|---|---|---|---|
| | *RD/Sales* | | ln(*TFP*$_{OP}$) | | *Tech. Efficiency* | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.003*** | | 0.012*** | | 0.031*** | |
| | (0.009) | | (0.003) | | (0.004) | |
| *ETS* × *Post* × *HP Firm* | | 0.005*** | | 0.020*** | | 0.054*** |
| | | (0.001) | | (0.000) | | (0.000) |
| *ETS* × *Post* × *LP Firm* | | 0.000 | | -0.004 | | -0.013 |
| | | (0.947) | | (0.438) | | (0.455) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,754 | 15,734 | 15,106 | 15,094 | 15,732 | 15,712 |
| Adjusted $R^2$ | 0.607 | 0.608 | 0.864 | 0.865 | 0.507 | 0.510 |
| p-value | — | 0.034 | — | 0.000 | — | 0.001 |

| Panel B: The Heterogeneous Effects of ETS on R&D, TFP, and Technical Efficiency | | | | | | |
|---|---|---|---|---|---|---|
| | *RD/Sales* | | ln(*TFP*$_{OP}$) | | *Tech. Efficiency* | |
| | HP Firm | LP Firm | HP Firm | LP Firm | HP Firm | LP Firm |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* × *FC Firm* | 0.007*** | 0.007* | 0.028*** | 0.008 | 0.077*** | 0.017 |
| | (0.001) | (0.075) | (0.000) | (0.524) | (0.000) | (0.641) |
| *ETS* × *Post* × *FU Firm* | 0.000 | 0.001 | 0.005 | -0.001 | -0.002 | 0.012 |
| | (0.922) | (0.643) | (0.366) | (0.896) | (0.889) | (0.558) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 11,338 | 4,227 | 10,934 | 4,008 | 11,318 | 4,225 |
| Adjusted $R^2$ | 0.613 | 0.507 | 0.825 | 0.894 | 0.525 | 0.478 |
| p-value | 0.023 | 0.162 | 0.007 | 0.511 | 0.000 | 0.913 |

| Panel C: The Interplay between Financial and Investment Responses | | | |
|---|---|---|---|
| | *RD/Sales* | ln(*TFP*$_{OP}$) | *Tech. Efficiency* |
| | (1) | (2) | (3) |
| *ETS* × *Post* × *LR Up* | 0.007*** | 0.021*** | 0.051*** |
| | (0.000) | (0.000) | (0.000) |
| *ETS* × *Post* × *LR Down* | -0.002 | -0.004 | -0.001 |
| | (0.335) | (0.485) | (0.974) |
| Firm FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 15,521 | 14,886 | 15,499 |
| Adjusted $R^2$ | 0.600 | 0.866 | 0.508 |
| p-value | 0.000 | 0.000 | 0.008 |

Note: *HP Firm* (*LP Firm*) is a dummy variable for high-polluting (low-polluting) firms. *FC Firm* (*FU Firm*) is a dummy variable for financially constrained (unconstrained) firms. *LR Up* (*LR Down*) is a dummy variable for firms that increased (did not increase) their leverage ratio ex post. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

Table OA12: ETS, Innovation, and Productivity (Including Control Variables)

Panel A: The Effects of ETS on R&D, TFP, and Technical Efficiency

| | *RD/Sales* | | $\ln(TFP_{OP})$ | | *Tech. Efficiency* | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* | 0.002* | | 0.050** | | 0.023** | |
| | (0.052) | | (0.018) | | (0.012) | |
| *ETS* × *Post* × *HP Firm* | | 0.004** | | 0.083*** | | 0.042*** |
| | | (0.021) | | (0.001) | | (0.000) |
| *ETS* × *Post* × *LP Firm* | | 0.000 | | -0.011 | | -0.011 |
| | | (0.868) | | (0.735) | | (0.496) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variable | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,754 | 15,734 | 14,954 | 14,942 | 15,732 | 15,712 |
| Adjusted $R^2$ | 0.604 | 0.604 | 0.872 | 0.872 | 0.545 | 0.546 |
| p-value | — | 0.155 | — | 0.018 | — | 0.005 |

Panel B: The Heterogeneous Effects of ETS on R&D, TFP, and Technical Efficiency

| | *RD/Sales* | | $\ln(TFP_{OP})$ | | *Tech. Efficiency* | |
|---|---|---|---|---|---|---|
| | HP Firm | LP Firm | HP Firm | LP Firm | HP Firm | LP Firm |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *ETS* × *Post* × *FC Firm* | 0.006*** | 0.005 | 0.125*** | 0.015 | 0.067*** | 0.001 |
| | (0.009) | (0.189) | (0.001) | (0.828) | (0.000) | (0.971) |
| *ETS* × *Post* × *FU Firm* | 0.001 | -0.001 | 0.014 | 0.007 | -0.006 | 0.009 |
| | (0.768) | (0.770) | (0.667) | (0.868) | (0.712) | (0.642) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Variable | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 11,495 | 4,239 | 10,934 | 4,008 | 11,318 | 4,225 |
| Adjusted $R^2$ | 0.617 | 0.525 | 0.848 | 0.895 | 0.557 | 0.503 |
| p-value | 0.091 | 0.179 | 0.016 | 0.910 | 0.000 | 0.819 |

Panel C: Financial Leverage and The Effects of ETS on R&D, TFP, and Technical Efficiency

| | *RD/Sales* | $\ln(TFP_{OP})$ | *Tech. Efficiency* |
|---|---|---|---|
| | (1) | (2) | (3) |
| *ETS* × *Post* × *LR Up* | 0.005*** | 0.079*** | 0.043*** |
| | (0.002) | (0.003) | (0.000) |
| *ETS* × *Post* × *LR Down* | -0.002 | 0.002 | -0.007 |
| | (0.315) | (0.951) | (0.620) |
| Firm FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Control Variable | Yes | Yes | Yes |
| Observations | 14,897 | 14,270 | 15,499 |
| Adjusted $R^2$ | 0.561 | 0.871 | 0.543 |
| p-value | 0.002 | 0.062 | 0.005 |

Note: *HP Firm* (*LP Firm*) is a dummy variable for high-polluting (low-polluting) firms. *FC Firm* (*FU Firm*) is a dummy variable for financially constrained (unconstrained) firms. *LR Up* (*LR Down*) is a dummy variable for firms that increased (did not increase) their leverage ratio ex post. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.

Table OA13: Source of Financing, Financial Leverage, Innovation, and Productivity

| Panel A: Trade Credit, Financial Leverage, Innovation, and Productivity | | | | | |
|---|---|---|---|---|---|
| | *Liability/BA* | *NIBL/BA* | *RD/Sales* | $\ln(TFP_{OP})$ | *Tech. Eff.* |
| | (1) | (2) | (3) | (4) | (5) |
| *ETS × Post × TC Up* | 0.055*** | 0.053*** | 0.004** | 0.123*** | 0.058*** |
| | (0.000) | (0.000) | (0.015) | (0.000) | (0.000) |
| *ETS × Post × TC Down* | -0.021** | -0.028*** | 0.001 | -0.024 | -0.011 |
| | (0.015) | (0.000) | (0.743) | (0.434) | (0.400) |
| Firm FE | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,522 | 15,522 | 15,521 | 14,886 | 15,499 |
| Adjusted $R^2$ | 0.826 | 0.788 | 0.597 | 0.870 | 0.544 |
| p-value | 0.000 | 0.000 | 0.106 | 0.000 | 0.000 |
| **Panel B: Dividend Policy, Financial Leverage, Innovation, and Productivity** | | | | | |
| | *Liability/BA* | *NIBL/BA* | *RD/Sales* | $\ln(TFP_{OP})$ | *Tech. Eff.* |
| | (1) | (2) | (3) | (4) | (5) |
| *ETS × Post × DPR Down* | 0.028*** | 0.017*** | 0.003* | 0.056** | 0.033** |
| | (0.001) | (0.003) | (0.094) | (0.046) | (0.009) |
| *ETS × Post × DPR Up* | -0.002 | 0.002 | 0.001 | 0.018 | 0.008 |
| | (0.783) | (0.736) | (0.517) | (0.514) | (0.564) |
| Firm FE | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Observations | 12,439 | 12,439 | 12,439 | 12,005 | 12,294 |
| Adjusted $R^2$ | 0.846 | 0.813 | 0.610 | 0.887 | 0.546 |
| p-value | 0.010 | 0.055 | 0.510 | 0.314 | 0.137 |
| **Panel C: Tax Avoidance, Financial Leverage, Innovation, and Productivity** | | | | | |
| | *Liability/BA* | *NIBL/BA* | *RD/Sales* | $\ln(TFP_{OP})$ | *Tech. Eff.* |
| | (1) | (2) | (3) | (4) | (5) |
| *ETS × Post × DETR Up* | 0.024*** | 0.026*** | 0.005** | 0.083** | 0.032** |
| | (0.006) | (0.000) | (0.013) | (0.010) | (0.022) |
| *ETS × Post × DETR Down* | 0.008 | -0.007 | 0.000 | 0.019 | 0.015 |
| | (0.365) | (0.193) | (0.868) | (0.464) | (0.218) |
| Firm FE | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Observations | 14,365 | 14,365 | 14,365 | 13,794 | 14,354 |
| Adjusted $R^2$ | 0.838 | 0.803 | 0.601 | 0.875 | 0.552 |
| p-value | 0.166 | 0.000 | 0.062 | 0.099 | 0.331 |

Note: *TC Up* (*DPR Up*) is a dummy variable for a firm with an average trade credit (dividend payout ratio) higher in the post-policy period than the pre-policy period. *TC Down* (*DPR Down*) is a dummy variable for the rest of the firm. *DETR Up* (*DETR Down*) equals one if a firm avoided (did not avoid) more tax in the post-policy period than in the pre-policy period; and zero otherwise. Standard errors are clustered at the firm level in parentheses. Significance level: ***=1%, **=5%, & *=10%. The sample period is 2009–2016. See Table A1 for detailed variable definitions.