Penny Wise and Pound Foolish:

Labor Adjustment Cost, Financial Constraint and Pollution Emissions

Yanan Li[1]

Wenjun Wang[2]

Abstract

This paper investigates the impact of intensified labor adjustment cost on corporate pollution emissions. We employ the enactment of China's Labor Contract Law in 2008 as a quasi-natural experiment to ascertain whether intensified labor protection has altered corporate emissions behavior. Our findings reveal that, for a one-standard-deviation increase in labor intensity, corporate COD emissions intensity experiences a 3.42% elevation. Heterogeneity analysis shows that this effect is particularly pronounced among non-state-owned enterprises, firms operating in regions with lax environmental regulations, and those with tight external financing constraints. Mechanism analysis indicates that the implementation of the Labor Contract Law heightens the likelihood of financial distress for affected firms, prompting cost-saving measures that result in reduced investments in pollution abatement and ultimately leading to an increase in corporate pollution emissions. Our paper offers empirical evidences on the unintended consequences of labor adjustment cost on firms' environmental behavior.

JEL Classification: G30 Q50 J32

Key Words: labor contract law; labor adjustment cost; pollution emissions

---

[1] Business School, Beijing Normal University. E-mail: yananli@bnu.edu.cn

[2] Investment Banking Division, Agricultural Bank of China. E-mail: wenjunwang00@gmail.com

1 Introduction

In the realm of economic dynamics, labor adjustment costs epitomize the financial expenditures borne by enterprises in the process of hiring, training, and terminating employees. The contemporary post-pandemic milieu, characterized by undulating business cycles and expeditious technological evolution, impels enterprises to transition swiftly toward resilient organizational structures (Pinheiro et al., 2022; Borms et al., 2023). However, the labor adjustment costs arising from the rigidity associated with hiring and firing practices attenuates firms' employment responses to economic fluctuations, thereby impacting corporate operations (Adhvaryu et al., 2013). While extant literature extensively explores the ramifications of labor adjustment costs on corporate financial and investment behaviors (Acharya et al., 2013; Acharya et al., 2014; Serfling, 2016; Qiu, 2019; Fairhurst et al., 2020), our research endeavors to unveil a potential externality stemming from such costs. Specifically, we investigate whether escalated labor adjustment costs induce a discernible response in pollution emissions among the affected firms.

Understanding the environmental implications becomes crucial for a comprehensive assessment of the true cost of organizational adjustments. Given the shared nature of the environment within society, any emissions resulting from manufacturing activities can be construed as a cost borne by the broader societal framework (Compagnie et al., 2023). Should manufacturing entities seek to offset augmented costs associated with human resources reallocation by diminishing efforts in pollution abatement, the entire society becomes encumbered by the ensuing externality. This underscores the intricate interplay between labor dynamics, financial considerations, and environmental impact within the evolving economic paradigm.

In our empirical research, we examine the impact of increased labor adjustment costs on firm pollutant emissions by leveraging the implementation of China's Labor Contract Law as an exogenous shock. Labor Contract Law, enacted in 2008, stands as China's most important labor protection legislation over the past 20 years (Li et al., 2020). This law enhances protections for workers in various aspects. For instance, it mandates written labor contracts between employers and employees, prohibits the abuse of probationary periods, broadens the scope of indefinite labor contracts, and requires employers to provide a certain amount of economic compensation in cases of termination (Gallagher et al., 2015). The law imposes stronger constraints on firms in terms of recruiting and dismissing employees, thereby reducing the flexibility in adjusting human capital within firms (Cooper et al., 2018; Cui et al., 2018).

The empirical analysis follows a difference-in-differences framework, leveraging the implementation of the 2008 Labor Contract Law as a quasi-natural experiment. We combine data from the Annual Survey of Industrial Firms (ASIF) database and the Environmental Survey and Reporting (ESR) database from 2003 to 2013. The empirical findings reveals a significant impact of the law's implementation on the corporate emission intensity of Chemical Oxygen Demand (COD). Specifically, subsequent to the enforcement of the law, an increase in labor intensity by one standard deviation is associated with a notable 3.42% rise in COD emission intensity. Similar conclusions were drawn when considering sulfur dioxide, industrial wastewater, and ammonia nitrogen emission intensities as alternative indicators of pollution emissions. Our results are robust to various checks such as parallel trend tests, PSM-DID, permutation test and excluding the confounding effect of the 2008 financial crisis.

Cross-sectional analysis reveals that the impact of the Labor Contract Law is more pronounced for non-state-owned firms, firms operating in regions with less stringent environmental regulations, and firms facing tighter external financing constraints. Mechanism analysis indicates that the law led to an increase in operating leverage, heightening financial distress risk for these firms. This escalation in financial pressure subsequently led to a reduction in pollution abatement efforts, both in terms of production processes and end-of-pipe treatments, resulting in increased pollution emission intensity. Our conclusion offers pertinent policy implications that the government needs to consider the overall societal welfare when designing labor policies. Furthermore, our findings underscore the need for stricter environmental regulations to mitigate firms' tendencies to cut costs on pollution abatement.

The primary contribution of this paper is to establish a connection between labor adjustment costs and corporate pollution emissions. Previous research on labor adjustment costs has primarily focused on the context of U.S. Wrongful Discharge Laws and labor unionization, with a few based on China's 2008 Labor Contract Law. These studies have demonstrated that such policies significantly increased firing costs and overall labor expenses for firms, which in turn affected various financial dimensions, such as corporate leverage (Chen et al., 2012; Serfling, 2016), risk management (Qiu, 2019), tax avoidance (Fairhurst et al., 2020), capital expenditure (Bai et al., 2020), and innovation (Acharya et al., 2013; Acharya et al., 2014), increased cash holdings and reductions in output and productivity among firms (Cui et al., 2018; Cooper et al., 2018). However, there is limited evidence on how labor adjustment costs specifically impact corporate environmental behavior. This paper extends the existing literature by investigating the effects of labor adjustment costs on firms' environmental practices.

This article contributes to the existing body of literature on corporate pollution decisions by emphasizing the labor policy as a key factor influencing environmental behavior. While previous studies have primarily examined the effects of environmental regulations on corporate pollution levels (Becker et al., 2013; Karplus et al., 2018; Shapiro and Walker, 2018; He et al., 2020; Mao et al., 2023), there has been a growing interest in the impact of non-environmental regulations (Liu et al., 2021b; Kong and Zhu, 2022; Rodrigue et al., 2022a and 2022b; Chen et al., 2023; Qi et al., 2023). Our study adds to this emerging literature by offering new insights into how labor market frictions shape corporate emissions decisions. This approach not only deepens the understanding of corporate environmental actions but also provides valuable policy implications for managing the interaction between labor market factors and environmental objectives.

This article aligns itself with the discussions on corporate responses to financial constraints. One way to deal with financial constraints is to use internal financing (Almeida and Campello, 2010; Qiu, 2019). Our results illustrate a novel economic mechanism through which firms generate internal financing by circumventing the costly measures associated with emission abatement, thereby externalizing these costs onto society (Liu et al., 2021a; Xu and Kim, 2022). In particular, in the face of heightened labor adjustment costs, firms are driven to curtail efforts in pollution abatement as a strategic measure to safeguard cash flow. This underscores a nuanced trade-off confronting firms — the delicate balance between investing in environmental sustainability and maintaining adequate internal funds for diverse operational needs. The identification of this hitherto unexplored economic channel broadens the understanding of the multifaceted decisions undertaken by firms in the realm of corporate finance and environmental stewardship.

The remainder of our paper is as follows: Section 2 introduces the institutional background and literature review; Section 3 proposes research hypotheses; Section 4 discusses the methodology and data; Section 5 reports empirical results and conduct robustness checks; Section 6 investigates the underlying mechanisms; and Section 7 concludes.

2 Institutional Background

The Labor Contract Law, which came into force on 1 January 2008, marked a significant milestone in China's labor legislation. This law, passed by the National People's Congress, aimed to regulate the labor market, protect the rights of employees, and provide a legal framework for employment relationships. Prior to its enactment, China's labor market faced several challenges and issues, such as informal employment, lack of standardized employment practices and limited legal protection regarding termination procedures, and dispute resolution (Gallagher et al., 2015; Li et al., 2022). As China's economy expanded, there was a growing need to establish clear guidelines for labor contracts, working conditions and dispute resolution.

The Labor Contract Law was formulated to tackle these challenges by introducing provisions that regulate labor contracts. These include mandates for written contracts, delineation of employee rights, specification of employment terms, and guidelines for termination procedures. Moreover, the law aimed to reduce labor exploitation, enhance working conditions, and institute a more equitable dispute resolution mechanism for both employees and employers (Li et al., 2020). According to the Ministry of Human Resources and Social Security of China, labor disputes in 2008 rose to 693,000, a near doubling of cases from 2007, with most of the cases relating to severance payment upon dismissal.

One of the most economically important provisions is the law's requirement on firms' hiring and layoffs (Cooper et al., 2018). First, the law required firms to sign written contracts with full-time employees, clearly defining the rights and obligations of both parties, to facilitate the fulfillment of labor contracts and the resolution of disputes. Second, the law regulates the probationary period, preventing firms from artificially extending the probationary period to save costs. Third, it allowed qualified employees, such as those with a decade of uninterrupted service within the same firm, to suggest the implementation of open-ended contracts, which enterprises are not permitted to reject (Li and Freeman, 2015). Fourth, it required that employers provide severance payment upon separation. The law stipulates that for lawfully terminated contracts the severance pay is one month's salary for each year of employment, capped at 12 months or 12 times 300% of the local average monthly salary, whichever is bigger. The severance is twice this amount if a contract is terminated unlawfully. These requirements have significantly increased labor adjustment costs for firms, rendering the processes of hiring and termination more economically burdensome (Cooper et al., 2018; Cui et al., 2018).

The enactment of the 2008 Labor Contract Law in China is characterized as an exogenous and unforeseen shock to firms, a perspective emphasized in previous studies (Cui et al., 2018; Li et al., 2020; Li et al., 2022). The law underwent substantial revisions from its initial draft release in March 2006 until its eventual passage in June 2007. The revision was primarily carried out by the Standing Law Committee of the National People's Congress. This process created a scenario where firms had limited access to the final version of the law, preventing them from anticipating and preparing for the forthcoming changes. The inability to access the finalized law and the anticipated increase in labor adjustment costs dissuaded firms from preemptively adapting to the new regulations. This context highlights the law's exogenous nature and underscores the regulatory shift as an externally imposed and unforeseen event affecting corporate outcomes.

3 Literature Review and Hypothesis Development

3.1 Related literature

The focus of our paper intersects with two distinct strands of literature. The first strand relates to the examination of the impact of labor adjustment costs on corporations, with prior studies employing the adoption of U.S. Wrongful Discharge Laws or the presence of labor unionization as empirical settings. Studies find that these two policies substantially increased firing costs and overall labor expenses for firms, which further influences corporations from both financial and operative perspectives (Bird and Knopf, 2009; Marciukaityte, 2018).

The literature underscores the significant role of labor adjustment costs in shaping corporate financial behavior and decision-making processes. For instance, research by Chen et al. (2012) and Serfling (2016) reveals that labor adjustment costs contribute to elevated financial distress costs, potentially crowding out financial leverage. Qiu (2019) observes that higher labor adjustment costs incentivize firms to engage in corporate derivative hedging as a strategy to smooth their internal funds. Additionally, Fairhurst et al. (2020) find that the adoption of wrongful discharge laws prompts firms to participate in less tax avoidance, aiming to mitigate increased distress risk. This body of literature establishes a foundation for understanding the effects of labor adjustment costs on corporate financial outcomes.

Prior studies have also examined the influence of labor adjustment costs on corporate real investment and innovation. For example, Bai et al. (2020) demonstrates that higher firing costs discourage investment by rendering projects more irreversible. Additionally, the influence of labor adjustment costs extends to the realm of innovation. Acharya et al. (2013) and Acharya et al. (2014) find that wrongful discharge laws, which increase labor adjustment costs, limit employers' ability to prevent innovative employees from leaving after their successful contributions. This limitation enhances the incentives for employees to engage more actively in innovative efforts, fostering a more dynamic innovation environment within the organization. Hence, the literature demonstrates that labor adjustment costs have multifaceted effects on corporations, influencing both financial outcomes and operational aspects such as investment and innovation.

In the study context of China, some recent research has utilized China's Labor Contract Law as an empirical setting to examine the impact of labor adjustment costs on corporate behavior. Notably, Cui et al. (2018) find that labor adjustment costs under the Labor Contract Law contribute to an increase in firms' cash holdings. Additionally, research by Jiang and Chen (2021) suggests that these costs are associated with a decline in firms' risk-taking behaviors. However, there is a noticeable gap in the literature regarding how labor adjustment costs influence corporations specifically from the perspective of environmental behavior. This paper addresses this gap by exploring how labor adjustment costs influence environmental practices within firms.

Our paper contributes to the second stream of literature, which examines the factors influencing corporate pollution emissions. Environmental regulations are recognized as a key determinant in mitigating corporate pollution. Both command-and-control measures (such as emission standards) and market-based approaches (like cap-and-trade programs) effectively increase the cost of pollution for firms, thereby incentivizing them to reduce emissions (Wang and Wheeler, 2000; Kathuria, 2006; Fowlie, 2010; Shapiro and Walker, 2018; Liu et al., 2023; Mao et al., 2023).

Recent studies have begun to explore how non-environmental regulations impact corporate emissions. For example, international trade has been identified as a significant factor influencing environmental decisions. Trade liberalization enables manufacturers to invest in cleaner production methods, which helps reduce emissions intensity (Levinson, 2009; Jiang et al., 2014; Rodrigue et al., 2022a and 2022b). Additionally, financial constraints emerge as another influencing factor – firms facing financial limitations may have higher pollution emissions because they tend to reduce expenditures on pollution abatement, given that their private costs of pollution abatement are smaller than the social cost (Andersen, 2017; Xu and Kim, 2022). Furthermore, recent literature has explored the impact of fiscal policies (Kong and Zhu, 2022; Qi et al., 2023) and corporate governance (Liu et al., 2021a) on firm-level emission decisions. We add to this literature by investigating the determinant of corporate environmental behavior from the perspective of labor market frictions.

3.2 Hypothesis Development

Given the uncertainty ex-ante regarding firms' responses to labor adjustment costs, a plausible scenario emerges where firms, seeking to alleviate financial strains stemming from increased labor costs, may reduce investments in pollution abatement measures. This potential strategy could lead to an increase in pollution emissions.

The heightened labor adjustment costs reduce firms' flexibility in adjusting their labor force in response to economic conditions (Messina and Vallanti, 2007; Kugler and Pica, 2008). Consequently, labor costs become more fixed, increasing operating leverage and the likelihood of financial distress, all else being equal (Simintzi et al., 2015; Serfling, 2016; Cui et al., 2018).

To enhance cash flow and mitigate financial risks, firms may opt to cut back on expenditures related to pollution abatement, potentially resulting in heightened pollutant emissions. From a corporate perspective, reducing pollution control expenditures proves more effective in easing financial strain compared to cuts in research and advertising (Liu et al., 2021a). Absent regulatory fines and penalties, reducing investments in pollution abatement yields cost savings for firms, with the external costs predominantly borne by society. Whether by scaling back end-of-pipe treatments or tightening initial pollution controls, these measures bolster cash flow, serving as a means of financial relief (Qi et al., 2023).

In light of this analysis, the implementation of the Labor Contract Law is anticipated to heighten financial risks for firms. Faced with the imperative of cost reduction, firms are likely to trim spending on pollution abatement, potentially amplifying pollutant emissions. Therefore, we propose the following hypothesis:

H1a: A firm's pollution emissions increase with higher labor adjustment cost.

Conversely, insights gleaned from existing literature suggest that heightened labor adjustment costs may lead to reductions in pollution emissions. First, as governmental policy interventions increasingly emphasize firms' corporate social responsibility (CSR) performance and labor protections promote a more employee-centric approach, stringent labor regulations could serve as a catalyst for firms to reevaluate their CSR commitments (Dawkins, 2010; Sobczak and Havard, 2015). This regulatory rigor might compel firms to broaden their awareness of societal responsibilities, potentially influencing other CSR initiatives, including environmental stewardship. Prior research suggests that heightened labor standards could indirectly prompt firms to adopt more environmentally sustainable practices in the short term (Shangguan and Feng, 2024).

Secondly, the increased costs associated with labor adjustments might incentivize firms to invest in technology and automation (Acemoglu and Finkelstein, 2008; Fan et al., 2021). Technological advancements often enhance production efficiency, thereby reducing resource consumption and emissions per unit of output (Liu et al., 2021b). Consequently, higher labor costs could spur technological innovation aimed at mitigating environmental impact.

In summary, there are compelling grounds to anticipate that elevated labor adjustment costs will not inadvertently exacerbate pollution emissions. On the contrary, existing literature hints that firms may decrease their environmental footprint in response to heightened societal pressures and technological advancements. Thus, we propose an alternative hypothesis:

H1b: A firm's pollution emissions decrease with higher labor adjustment cost.

4 Methodology and Data

4.1 Identification Strategy

Our paper leverages the implementation of the 2008 Labor Contract Law as an exogenous shock to examine the impact of labor adjustment costs on corporate emission intensity of pollutants. As the Labor Contract Law is a nationwide regulation unaffected by individual firms, it can be regarded as an exogenous shock for corporations. The law enhances employee protection especially during the firms' hiring and dismissal process, thereby increasing the labor adjustment cost for firms. In spirit of Cui et al. (2018), our hypothesis argues that the Labor Contract Law exerts a relatively larger impact on firms that are more labor-intensive, as labor costs account for a larger proportion of total cost for these firms.

We employ a difference-in-difference approach to estimate the impact of labor adjustment cost on the intensity of pollutant emissions by firms:

$$\boldsymbol{Y_{it} = \alpha_0 + \alpha_1 LaborIntensity_i \times Post_t + \beta X_{it} + \kappa_i + \delta_{st} + \varphi_{pt} + \varepsilon_{it}}, \quad (1)$$

where $\boldsymbol{Y_{it}}$ represents pollution emission intensity for firm *i* in year *t*; $\boldsymbol{Post_t}$ is a dummy variable that equals to one for the years 2008 through 2013 and zero for years 2003 through 2007; $\boldsymbol{LaborIntensity_i}$ is the labor intensity variable for firm *i* at the end of 2007; $\boldsymbol{X_{it}}$ is firm-level control variables. $\boldsymbol{\kappa_i}$ is firm-level fixed effect, $\boldsymbol{\delta_{st}}$ is industry-year fixed effects, $\boldsymbol{\varphi_{pt}}$ is province-year fixed effect, $\boldsymbol{\varepsilon_{it}}$ is the error term clustered at the firm-level.

4.2.Data and Sample

The data utilized in our study is sourced from a consolidated dataset comprising the Annual Survey of Industrial Firms (ASIF) database and the Environmental Survey and Reporting (ESR) database. The chosen sample period encompasses the years 2003 to 2013, allowing for the collection of data for five years preceding and following the enactment of the Labor Contract Law in 2008.

We further refine the dataset as follows. Primarily, only firms within the manufacturing industry were retained, and those with observations solely before or after the implementation of the law were removed. Subsequently, to mitigate the influence of outliers, the dependent and independent variables were subjected to winsorization at the 1^{st} and 99^{th} percentiles. Following these procedures, the final dataset for our study includes 26,457 firms, with 176,494 firm-year observations.

4.3 Variable Construction

The dependent variable used in our study is the intensity of Chemical Oxygen Demand (COD) emitted by firms, which is calculated as the COD emissions divided by the firm's total output value (He et al., 2020; Chen et al., 2021). To mitigate the impact of outliers, we take the natural logarithm. There are two reasons for using COD emission intensity to gauge the firm's pollution emissions. First, COD serves as a crucial indicator of water pollution. It refers to the amount of oxidant consumed when treating a water sample with a designated strong oxidizing agent, and is widely used to measure the content of organic substances in water. A higher COD indicates a more severe contamination of organic substances in the water. COD has been regarded as a key pollutant emission in China, and the 11^{th} Five-Year Plan (2006-2010) mandated a 10% reduction in China's total COD emissions. Second, the data quality of COD in ESR database is relatively high. Compared to other pollutants reported, such as sulfur dioxide, ammonia nitrogen and industrial wastewater, data for COD emission has fewer missing observations, thereby providing richer information regarding firm-level pollution emissions.

The independent variable employed in our study is the firm-level labor intensity, which captures a firm's exposure to the 2008 Labor Contract Law. It is specifically delineated as the ratio between the number of employees within a firm at the end of 2007 and its fixed assets (Cui et al., 2018). A higher ratio signifies an elevated degree of labor intensity within the firm, concomitantly reflecting a more pronounced impact of the Labor Contract Law.

Regarding for the controls, we incorporate variables commonly employed in studies on firm-level pollution emissions (Chen et al., 2021; Kong and Zhu, 2022; Qi et al., 2023). We include the natural logarithm of total assets as proxies for firm size (*Size*). We control for debt ratio (*Debt*), as firms with greater debt are motivated to expand production. The proportion of tangible assets (*Tangibles*), calculated as fixed assets divided by total assets, may also influence firms' pollution emission.[3] We include firm exports (*Export*), calculated as the value of export output divided by total sales, to capture the impact of foreign trade on environmental performance (Rodrigue et al., 2022a and 2022b). Table 1 presents the descriptive summary for the key variables in our study.

5 Empirical Analysis

5.1 Baseline results

Table 2 presents the empirical findings elucidating the impact of the Labor Contract Law implementation on corporate pollution emissions, employing the baseline model articulated in Equation (1). Column (1) includes firm fixed effects and industry-year fixed effects but no controls. Column (2) incorporates control variables in addition to firm fixed effects and industry-year fixed effects. Column (3) extends the analysis with the inclusion of province-year fixed effects. Column (4) provides a comprehensive model by encompassing all relevant fixed effects and control variables.

The primary focus of our analysis is the coefficient of the interaction term between *Labor* and *Post,* serving as a metric for the alteration in COD emission intensity consequent to the enactment of the Labor Contract Law. Across Columns (1)-(4), a consistent and statistically significant positive coefficient on *Labor Intensity* × *Post* at the 1% significance

[3] Certain control variables, *Debt* and *Tangibles*, have a lot of missing values for the year 2010. We impute the missing values by using observations from the year 2009.

level is observed, signifying a discernible escalation in pollution emissions intensity for labor-intensive firms during the post-policy period. This empirical outcome substantiates our hypothesis H1a.

The economic implications of our estimations are significant. In Column (4), the coefficient on the interaction term is 0.089. Given the standard deviation of labor intensity at 0.384 (as detailed in Table 1), a one-standard-deviation augmentation in labor intensity yields a substantial 3.42% upswing in COD emission intensity. To put this into perspective, with the average COD emission intensity for our sample firms standing at 8.224 kg per 10,000 yuan of output, this implies a quantifiable increase of 0.281 kg (8.224 multiplied by 3.42%) in COD emissions for every 10,000 yuan of total output generated by firms. These findings provide valuable insights into the complex relationship between labor policies and environmental outcomes in the corporate landscape.

To evaluate the economic consequences of the labor contract law on emissions, we compare our estimated effect size with findings from studies that focus on other labor-related policies as well as both environmental and non-environmental regulations. Our results are consistent with prior research examining the impact of labor policies on corporate financial metrics. For instance, Cui et al. (2018) explored how labor adjustment costs influence corporate cash reserves, noting that a one-standard-deviation rise in labor intensity corresponds with an 8.12 percentage point increase in average corporate cash holdings following the introduction of China's Labor Contract Law. Moreover, our effect size parallels those identified in studies of other non-environmental policy shocks on corporate emissions. Chen et al. (2023), for example, investigated the effect of financing costs on environmental performance, discovering that companies located in cities with one standard deviation higher exposure to the 2009 bank deregulation policy showed a 6.70% larger decline in average COD emissions intensity. Additionally, our effect size remains substantial when compared to the effects of environmental regulations. For example, Karplus et al. (2018) reported that coal power plants subject to stricter SO_2 emission standards in China experienced an average emission concentration drop of about 13.9%.

5.2 Robustness Checks

5.2.1 Parallel trend assumption

The foundational tenet of the difference-in-differences model relies on the parallel trends assumption. In the context of our investigation, this assumption implies that, prior to the enactment of the Labor Contract Law, firms with different levels of labor intensity exhibit similar trends in COD emission intensity. To validate the parallel trends assumption, we analyze the dynamic effects of the implementation of the Labor Contract Law. This approach enables us to evaluate whether firms with varying labor intensities followed comparable pre-treatment trends, thereby strengthening the robustness of our empirical framework. The econometric regression equation is specified as follows:

$$Y_{it} = \alpha_0 + \sum_{t=2003}^{2013} \theta_t Labor_i \times Year_t + \beta X_{it} + \kappa_i + \delta_{st} + \varphi_{pt} + \varepsilon_{it}, \quad (2)$$

where the year 2007 is designated as the baseline for analysis. $Year_t$ represents a yearly dummy variable, and θ_t is the parameter of primary concern, with other symbols maintaining the same meanings as in Equation (1). The interpretation of parameter θ_t lies in determining whether, in comparison to 2007, firms with varying degrees of labor intensity exhibit noticeable differences in COD emission intensity. If θ_t is not statistically significant before the promulgation of the Labor Contract Law, it provides support for the parallel trends assumption. Figure 1 depicts the estimated values of θ_t along with a 95% confidence interval. The results indicate that there are no significant effects in the periods prior to the law's implementation, confirming that the DID model successfully meets the parallel trends test. Additionally, post-implementation of the Labor Contract Law, the estimated coefficient θ_t is significantly positive, indicating that firms with higher pre-existing labor intensity manifest heightened pollution emissions intensity. Notably, this impact did not manifest in the initial year of policy enforcement in 2008 but gradually unfolded in subsequent years, with the impact intensifying over time.

5.2.2 PSM-DID.

While the DID model in our study meets the parallel trends assumption, systematic differences among firms with varying labor intensity may potentially introduce biased estimation results. To address this possibility, our paper employs propensity score matched DID model (PSM-DID) to validate the robustness of the baseline results.

Concretely, we classify firms with labor intensity surpassing the median as the treatment group (*High Labor Intensity*=1), with those falling below the median designated as the control group (*High Labor Intensity*=0) by the conclusion of 2007. We use the Propensity Score Matching method to perform the match between treatment and control groups with the same control variables utilized in the baseline regression, by implementing nearest neighbor matching algorithms. To fortify the robustness of our findings, we employ varying matching ratios, specifically 1:4, 1:6, and 1:8, in constructing the matched samples.

We evaluate the success of the matching process using a balance test. For example, Figure A1 depicts the propensity score distributions for the 1:4 nearest-neighbor matching, both before and after the procedure. A visual inspection suggests that PSM significantly mitigates the bias between the treatment and control groups. Furthermore, Figure A2 emphasizes the changes in covariates pre- and post-matching, showing that the differences across all variables shrink to under 3%, thereby supporting the balance hypothesis. Comparable outcomes are evident in the 1:6 and 1:8 matching cases as well.

Subsequently, we conduct a Difference-in-Differences (DID) analysis utilizing these matched samples, and the ensuing results are delineated in Table 3. This methodological rigor ensures the reliability of our empirical outcomes. In columns (1)-(3) of our analysis, the coefficients associated with *High Labor Intensity*×*Post* are not only positive but also achieve statistical significance at conventional levels. This implies that following the implementation of the Labor Contract Law, firms characterized by high labor intensity (belonging to the treatment group) demonstrate a notable increase in COD emission intensity ranging from 4.90% to 7.40% in comparison to firms with lower labor intensity (from the control group). The robust statistical significance underscores the substantive impact of the labor contract regulations on COD emission patterns among firms with varying labor intensity levels.

Furthermore, we compare the results in our PSM-DID analysis with that in our baseline regression as reported in Table 2. Given that the average labor intensity in the treatment group (0.557) exceeds that in the control group (0.081) by 0.476 (equivalent to 1.24 times the standard deviation of labor intensity in Table 1), this implies that for a one-standard-deviation increase in labor intensity, COD emission intensity increases by 3.95%-5.97%, aligning broadly with the results in Table 2. This suggests that the findings in our study is not driven by systematic differences among different firms and has withstood robustness checks.

5.2.3 Alternative measures for pollution emission

In our baseline regression, we adopt COD emission intensity as a proxy for corporate pollution levels. To ensure the robustness of our findings, we incorporate three alternative metrics. The first metric addresses air pollution, using sulfur dioxide (SO2) emission intensity, defined as the ratio of sulfur dioxide emissions to corporate industrial output. The second metric focuses on water pollution, measured through industrial wastewater emission intensity, calculated as the ratio of wastewater emissions to corporate industrial output. The third metric, also related to water pollution, uses ammonia nitrogen emission intensity, expressed as the ratio of ammonia nitrogen emissions to corporate industrial output. We rerun our regression in Equation (1) using these alternative measures and the results are presented in Table 4.

In column (2), it shows that a one-standard-deviation increase in labor intensity results in a 2.7% increase in industrial wastewater emission intensity (0.384*0.07). Column (3) employs ammonia nitrogen emission intensity as the dependent variable, yielding similar results. In column (1), the interaction term indicates a positive but insignificant effect on the emission intensity of sulfur dioxide. Overall, the regression outcomes suggest that post-implementation of the Labor Contract Law, firms experience an increase in the intensity of major pollutant emissions.

5.2.4 Alternative measures for exposure to the law

In our baseline model, we gauge firms' exposure to the Labor Contract Law by their labor intensity at the end of 2007. To ensure the robustness of our findings with respect to alternative treatment variable definitions, we incorporate two additional measures. First, we construct a indicator variable based on the labor intensity indicator in our baseline model, assigning a value of one if a firm's labor intensity at the end of 2007 surpasses the median of the sample distribution, and zero otherwise. This check is particularly useful because of the continuous nature of the labor intensity measure in the main model, which requires a key assumption that the average treatment effect remains constant across different levels of treatment intensities (Callaway et al. 2024). As noted by Thatchenkery and Katila (2023), using an indicator instead of a continuous treatment variables eases the interpretation of results and addresses treatment effect heterogeneity. Secondly, we employ the average labor intensities of firms during the period 2003-2007 as an alternative treatment variable.

The regression results presented in Table 5 reveal that the coefficient associated with the interaction term remains positive and statistically significant at the 1% level. This suggests that the conclusions drawn in our study are robust and not contingent on the specific method used to calculate labor intensity, affirming the consistency and reliability of our analytical approach.

5.2.5 Permutation Test

In order to tackle the potential issue of omitted variables that might influence our findings, we perform a falsification test as suggested by Chetty et al. (2009) and Mastrobuoni and Pinotti (2015). Specifically, for the firms' labor intensity at the end of 2007 in the sample, a non-repetitive random sampling is performed. The sampled values are then reassigned to the firms, creating spurious treatment variables. Subsequently, Equation (1) is re-estimated. Given the stochastic nature of the data-generating process, the interaction term *Labor*×*Post* for the new treatment variable and policy variable should ostensibly not impact a firm's pollution emissions. Drawing inspiration from Mastrobuoni and Pinotti (2015), this process is iterated 500 times, yielding 500 regression coefficient estimates and their corresponding *p*-values.

Figure 2 visually represents the estimation results, where the hollow blue circles depict the point estimates on the x-axis and corresponding *p*-values on the y-axis. The solid line illustrates the probability distribution of the point estimates, with the vertical line denoting the estimated coefficient of *Labor Intensity* × *Post* from the regression in column (3) of Table 2. The horizontal line signifies the 10% *p*-value threshold. If the conclusions drawn from our paper were coincidental and attributable to unobservable variables at the firm level, the estimates generated by random numbers should closely resemble those derived from actual data (represented by the vertical line). As depicted in Figure 2, the estimates generated by random numbers approximate a normal distribution centered around zero, with the majority of *p*-values exceeding 10%. This indicates that the conclusions of this paper remain unaffected by unobservable variables at the firm level.

5.2.6 Excluding the Impact of the 2008 Financial Crisis

The enactment of the Labor Contract Law coincided with the eruption of the global financial crisis in 2008. The occurrence of this crisis could potentially influence the firm's environmental decision-making. Therefore, it is imperative to control for this impact. Specifically, the global financial crisis had several potential effects on firms. Firms with high debt ratios experienced substantial financial shocks and, to cut costs, may have reduced expenditures on pollution abatement, thereby leading to increased pollution emissions. Additionally, the global financial crisis affected the export of labor-intensive products in China. However, in post-crisis periods, a series of market rescue measures were implemented by the government, potentially relaxing environmental regulation measures and resulting in increased pollution emissions from labor-intensive firms.

To account for the influence of the 2008 global financial crisis and disentangle its effects from those of the labor contract law, we incorporate several additional control variables. First, we generate a dummy variable *Leverage*, which equals one if the firm's financial leverage is above the median of its distribution and zeros otherwise. This variable is interacted with the crisis indicator *Post* and added to our baseline model. Second, we introduce a dummy variable *Trade* that equals one if the firm had exported goods in 2007 and zero otherwise. This variable is interacted with the crisis indicator (*Post*) to account for the impact on export-oriented firms. Third, following Cui et al (2018), we incorporate an interaction term for *Labor Intensity* × *Financial Crisis*, where *Financial Crisis* is assigned a value of one for the year 2008 and zero otherwise. Fourth, in spirit of Cui et al (2018), we also include another interaction term for *Labor Intensity* × *Post Stimulus*, with *Post Stimulus* designated as one for year 2011-2013 and zero otherwise. As the Chinese government initiated a stimulus package in response to the global financial crisis from December 2008 to the end of 2010, this interaction term could capture the impact of post-crisis market rescue measures.

The regression results are presented in Table 6. In columns (1) through (4), the coefficients between labor intensity and the policy indicator remain significant at the 1% level and have similar magnitude as that in the baseline regression results. This indicates that even after accounting for the impact of the 2008 global financial crisis, the implementation of the

Labor Contract Law continues to significantly increase corporate pollution emission intensity.

5.3 Robustness Checks

5.3.1 Ownership Structure

Within the Chinese institutional context, state-owned enterprises (SOEs) are known for their rigorous adherence to labor legislation, as highlighted by previous research (Cui et al., 2018; Liu et al., 2021b). Against this backdrop, the implementation of the Labor Contract Law introduces complex dynamics, with SOEs likely facing less significant policy impacts compared to non-SOEs. In light of this, our hypothesis is that the increase in pollution emission intensity following the enactment of the Labor Contract Law will be more pronounced among non-SOEs than SOEs. This conjecture arises from the understanding that regulatory changes may have varying effects depending on the ownership structure of the enterprises.

To test this hypothesis, we split the firms into two subsamples based on their ownership structure, i.e., SOEs and non-SOEs. Panel A in Table 7 reports the results of the subsample regression. The findings reveal a notable heterogeneity in policy effects between SOEs and non-SOEs. In the SOEs subsample, the coefficient of the interaction term between *Labor Intensity* and *Post* is negative but statistically insignificant. Conversely, in the non-SOE subsample, the coefficient on *Labor Intensity* × *Post* is positive and statistically significant at the 1% level. The difference in these coefficients is statistically significant at the 10% level (p-value = 0.088). This indicates that, following the implementation of the Labor Contract Law, non-SOEs experience a significantly greater pollution emission intensity compared to SOEs, aligning with our expectation.

5.3.2 Stringency of environmental regulation

Empirical investigations, as evidenced by works such as those by Shapiro and Walker (2018) and He et al., (2020), underscore the salience of environmental regulations as a determinative factor in shaping firms' pollution emission behaviors. Specifically, regions characterized by stringent environmental regulatory frameworks tend to witness a concomitant reduction in pollution emissions from firms, a trend that contrasts with the potential for heightened emissions in those with lax regulatory environments. Consequently, our conjecture hinges on the premise that the post-implementation landscape of the Labor Contract Law will yield a more conspicuous surge in pollution emission intensity among firms situated in regions marked by comparatively lax environmental regulations.

We use the city-level compliance rate of industrial wastewater discharge at the end of 2007 to proxy for the environmental regulation stringency across regions. This indicator is defined as the ratio of compliant industrial wastewater discharge to the total industrial wastewater discharge on the city level. A higher compliance rate implies stronger environmental regulations in that region.

Regions are categorized based on whether their compliance rate of industrial wastewater discharge surpasses (falls below) the median, delineating them as harboring either strong or weak environmental regulation. Panel B of Table 7 meticulously delineates the regression outcomes within distinct subsamples. Noteworthy is the discernible heterogeneity in policy effects across regions characterized by varying levels of regulatory stringency. Subsequent to the enactment of the Labor Contract Law, the escalation in pollution emission intensity for firms situated in regions marked by weak environmental regulations significantly eclipses that observed in areas characterized by robust environmental oversight. The observed disparity in coefficients attains statistical significance at the 10% level (p-value = 0.096), indicative of a substantive manifestation. This underscores that the amplified labor adjustment costs stemming from the legislative change exert a more pronounced influence on firms domiciled in regions with less stringent environmental regulations, relative to their counterparts operating in regions with more robust environmental oversight.

5.3.3 Financial Constraint

The literature highlights the significant impact of external financing constraints on corporate behavior. When a firm has better access to external financing, acquiring funding from external sources to underpin its investments on pollution abatement is easier (Chen et al., 2023; Qi et al., 2023). Pollution abatement investments, such as the installation of purification systems and the upgrading of production technologies, usually involve large expenditure but low initial returns. In the face of stringent financing constraints, firms are reluctant to allocate resources to abatement expenditure, consequently leading to an escalation in pollution emissions. Therefore, we postulates that following the implementation of the Labor Contract Law, firms facing tighter external financing constraints are anticipated to experience a more pronounced increase in pollution emission intensity compared to those with more favorable financing conditions.

We use the regional deposit balance to gauge external financing constraints, which is calculated as the ratio of deposit balances held by financial institutions at the city level to the local GDP at the end of 2007. Firms located in cities with deposit balance below (above) the median are classified as the group with tight (lax) financing constraints. The regression results presented in Panel C of Table 7 reveal conspicuous heterogeneity in policy effects among corporations subject to different financing constraints. The coefficient disparities between groups are statistically significant at the 1% level (p-value = 0.002). Post the enactment of the Labor Contract Law, firms confronted with tighter external financing constraints exhibit a discernible increase in pollution emission intensity, in stark contrast to their counterparts with more relaxed constraints.

6 Mechanism

In the preceding discussion, it was observed that, post the implementation of the Labor Contract Law, more labor-intensive firms exhibited a noticeable increase in pollution emission intensity compared to those with less labor-intensive firms. In our hypothesis development outlined in Section 3, we argue that heightened labor adjustment costs elevate a firm's operating leverage, thereby increasing the risk of financial distress. To mitigate financial distress risk, firms may reduce investments in pollution abatement, leading to an increase in pollution emission intensity. In this section, we empirically test this mechanism.

6.1 Operating Leverage

Serfling (2016) defines operating leverage as the increased percentage change in profits relative to a given percentage change in sales. Many manufacturers face significant fixed labor costs in their production and operational structures. The introduction of exogenous increases in these costs heightens operating leverage, which is understood as the ratio of fixed to total costs. This heightened leverage leads to greater vulnerability to financial distress, as detailed in the literature (Serfling, 2016; Cui et al., 2018; Dang et al., 2023). This concept is particularly relevant in the context of the Labor Contract Law, which imposes higher labor adjustment costs that tend to be fixed rather than variable for the average manufacturing firm. Thus, it can be anticipated that such firms will experience increased operating leverage, thereby elevating their risk of financial distress.

Building on the methodologies of Serfling (2016) and Cui et al. (2018), our empirical investigation employs the elasticity of a firm's operating income concerning total sales as a proxy for operating leverage. In light of the promulgation of the Labor Contract Law, we meticulously scrutinize alterations in the firm's operating leverage.

$$\%\Delta EBIT_{it} = \gamma_0 + \gamma_1 \%\Delta Sales_{it} \times Post_t + \gamma_2 \%\Delta Sales_{it} + \gamma_3 X_{it} + \kappa_i + \delta_{st} + \varphi_{pt} + \varepsilon_{it} \quad (8)$$

Where $\%\Delta EBIT_{it}$ represents the percentage change in a firm's earnings before interest and taxes (EBIT), $\%\Delta Sales_{it}$ is the percentage change in a firm's total sales revenue. Both of these variables have been winsorized at the 1% and 99% levels. The variable $Post_t$ and X_{it} maintain the same definitions as outlined in our baseline regression. κ_i is firm-level fixed effect, δ_{st} is industry-year fixed effect, φ_{pt} is province-year fixed effect, ε_{it} is error term clustered at the firm level.

In Table 8, Column (1) elucidates the findings of the regression analysis. The coefficient affiliated with the interaction term emerges as positive and attains statistical significance at the 1% threshold. This observation intimates that the promulgation of the Labor Contract Law has induced an augmentation in the responsiveness of the percentage change in earnings before interest and taxes (EBIT) to alterations in sales revenue. Preceding 2008, a 1% upswing in sales revenue precipitated a 0.885% elevation in EBIT, as denoted by an elasticity coefficient of 0.885. Following the enforcement of the Labor Contract Law, this elasticity coefficient experienced a supplementary increment of 0.151. Consequently, it is deduced that, on average, the Labor Contract Law has engendered a discernible escalation in the operating leverage of firms, quantified at 17.06% (calculated as 0.151/0.885).

Columns (2) and (3) furnish additional insights through subsample estimates. Notably, the coefficient linked to the interaction term exhibits greater magnitude for firms categorized within the treatment group, characterized by heightened labor intensity, relative to their counterparts in the control group. This discrepancy implies that subsequent to the Labor

Contract Law's enactment, enterprises with intensified labor intensity underwent a more pronounced surge in operating leverage, concomitant with an elevated risk of encountering financial distress.

6.2 Pollution Abatement Channel

To mitigate financial distress risk arising from labor adjustment cost, the firms may cut down their expenditure on pollution abatement. In comparison to investment in research and development outlays in advertising, the discernible advantages of diminishing expenditures on pollution abatement is evident (Liu et al., 2021a). In the absence of fines and penalties, reducing investments in pollution abatement saves cost for the firms, with the bulk of the resultant externalities borne by the society. There are two strategies that adopted by the corporations in pollution abatement (He et al., 2020; Qi et al., 2023). The first is end-of-pipe treatment, which involves the installation of treatment apparatuses to remove the pollution emission. The second is production processes reduction strategy, in which firms adopt new clean technology to reduce pollutant generated. We examine these two strategies on pollution abatement separately.

6.2.1 End-of-pipe treatment

End-of-pipe reduction strategy denotes the activity in which firms allocate resources towards pollution abatement after the production process. End-of-pipe treatment can be characterized by examining a firm's investments in abating wastewater pollution. Corporations use various methods to eliminate COD from industrial wastewater, such as separating suspended particles, removing dissolved substances, and transforming organic pollutants into harmless substances using physical, chemical, and biological treatment methods. Regardless of physical, chemical, or biological approaches, it incurs substantial expenditures on pollution control for the corporations.

We use two variables to proxy for end-of-pipe treatment. The first is the firm's maximum abatement capacity on industrial wastewater. The second is the number of wastewater abatement facilities. We examine the changes in firms' end-of-pipe abatement following the implementation of the Labor Contract Law and the results are presented in columns (1) - (2) of Table 9. The results reveal that, post-implementation of the Labor Contract Law, the firms' abatement capacity on industrial wastewater significantly decreased by 164 tons a day, while the number of abatement facilities for industrial wastewater remained largely unchanged.

The aforementioned regression results imply that, in the face of increased labor adjustment costs due to the implementation of the Labor Contract Law, firms have diminished their efforts in end-of-pipe treatment to save cash flow, partially offsetting the impacts of rising costs. Rather than reducing the number of abatement facilities, firms are more inclined to opt for temporarily switching off such facilities, as the their operation consumes substantial electrical power (Liu et al., 2021a), and curtailing the operational time of these facilities is an easier way to save costs. Overall, the regression results endorse the channel of end-of-pipe reduction strategy.

6.2.2 Production Processes Reduction Strategy

In addressing pollution emissions, firms can pursue reduction strategies within their production processes. One effective approach involves adopting cleaner technologies to mitigate pollution generated, thereby reducing overall emissions (Andersen, 2016; Gutiérrez and Teshima, 2018). Conversely, less efficient technologies tend to result in higher pollution emissions. Building on prior studies (Gutiérrez and Teshima, 2018; He et al., 2020; Chen et al., 2023), this study employs two key metrics to assess technological advancements in production processes. First, we utilize the natural logarithm of fresh water consumption per unit of output in manufacturing. Water resources are essential raw materials in production, and reduced fresh water usage can signify greater adoption of cleaner technologies (He et al., 2020; Chen et al., 2023). Second, we employ green patent applications as a measure of green technology innovation, calculated as the natural logarithm of the number of green patent applications plus one. These metrics collectively serve to quantify the extent of technological advancements in production processes and their implications for pollution reduction strategies.[4]

Columns (3) - (4) of Table 9 presents the regression results. In column (3), the coefficient

[4] The patent data used in this study originates from the State Intellectual Property Office (SIPO) in China. Specifically, green patents are identified through the International Patent Classification Index. The study employs the aggregated count of green patent applications as a key metric to gauge green technology innovation within the context of the research framework.

associated with the interaction term *Labor Intensity* × *Post* is positive and statistically significant. This finding suggests that firms tend to employ less clean technology in their production processes and utilize more fresh water resources following the implementation of the Labor Contract Law. Column (4) show significantly negative coefficients of interest, suggesting a reduced number of green patent applications. These results suggest that after the enactment of the Labor Contract Law, firms have reduced their investment in green innovation, likely leading to a higher environmental impact during production.

Overall, the regression results support the channel of reduction strategy in the production processes. In essence, in response to the financial distress stemming from the heightened labor adjustment cost caused by the law, firms opt to reduce their efforts in adoption of cleaner technology.

7 Conclusion

This study undertakes an examination of the impact of heightened labor adjustment costs on corporate pollution emissions. We leverage the enactment of China's Labor Contract Law as a quasi-natural experiment and employ a difference-in-differences approach to scrutinize the nexus between labor adjustment costs and corporate pollution behavior. The empirical findings of our study unveil a significant increase in the intensity of COD emissions by firms subsequent to the implementation of the Labor Contract Law. Specifically, for a one-standard-deviation elevation in labor intensity, the COD emission intensity experiences a notable uptick of 3.42%. Further cross-sectional analysis underscores that the impact of the Labor Contract Law on enterprise COD emission intensity is more pronounced for non-SOEs, firms situated in regions characterized by lax environmental regulations, and those grappling with stringent financing constraints. In our mechanism analysis, we first document an increase in financial distress arising from higher labor adjustment cost, then empirically scrutinize both end-of-pipe treatment and reduction strategies in production processes. The empirical results align with the anticipated mechanisms outlined in our hypothesis.

The implications of our findings extend to policy considerations. First, in formulating labor policies, governmental deliberations should encompass the broader societal welfare impact. Excessively stringent labor protection policies may yield unforeseen outcomes, potentially amplifying pollutant emissions by firms. Second, enhanced government oversight of environmental compliance is warranted to ensure that firms do not resort to pollution emissions as a means of transferring rising labor costs to society at large, thereby compromising environmental integrity.

Reference

Acemoglu, Daron, and Amy Finkelstein. "Input and technology choices in regulated industries: Evidence from the health care sector." *Journal of Political Economy* 116, no. 5 (2008): 837-880.

Acharya, Viral V., Ramin P. Baghai, and Krishnamurthy V. Subramanian. "Labor laws and innovation." *The Journal of Law and Economics* 56, no. 4 (2013): 997-1037.

Acharya, Viral V., Ramin P. Baghai, and Krishnamurthy V. Subramanian. "Wrongful discharge laws and innovation." *The Review of Financial Studies* 27, no. 1 (2014): 301-346.

Adhvaryu, Achyuta, Amalavoyal V. Chari, and Siddharth Sharma. "Firing costs and flexibility: evidence from firms' employment responses to shocks in India." *Review of Economics and Statistics* 95, no. 3 (2013): 725-740.

Almeida, Heitor, and Murillo Campello. "Financing frictions and the substitution between internal and external funds." *Journal of Financial and Quantitative Analysis* 45, no. 3 (2010): 589-622.

Andersen, Dana C. "Credit constraints, technology upgrading, and the environment." *Journal of the Association of Environmental and Resource Economists* 3, no. 2 (2016): 283-319.

Andersen, Dana C. "Do credit constraints favor dirty production? Theory and plant-level evidence." *Journal of Environmental Economics and Management* 84 (2017): 189-208.

Bai, John, Douglas Fairhurst, and Matthew Serfling. "Employment protection, investment, and firm growth." *The Review of Financial Studies* 33, no. 2 (2020): 644-688.

Becker, Randy A., Carl Pasurka Jr, and Ronald J. Shadbegian. "Do environmental regulations disproportionately affect small businesses? Evidence from the Pollution Abatement Costs and Expenditures survey." *Journal of Environmental Economics and Management* 66, no. 3 (2013): 523-538.

Bird, Robert C., and John D. Knopf. "Do wrongful-discharge laws impair firm performance?." *The Journal of Law and Economics* 52.2 (2009): 197-222.

Borms, Lize, Jan Brusselaers, Karl C. Vrancken, Sam Deckmyn, and Philip Marynissen. "Toward resilient organizations after COVID-19: An analysis of circular and less circular companies." *Resources, conservation and recycling* 188 (2023): 106681.

Callaway, Brantly, Andrew Goodman-Bacon, and Pedro HC Sant'Anna. *Difference-in-differences with a continuous treatment*. No. w32117. National Bureau of Economic Research, 2024.

Chen, Huafeng, Marcin Kacperczyk, and Hernan Ortiz-Molina. "Do nonfinancial stakeholders affect the pricing of risky debt? Evidence from unionized workers." *Review of Finance* 16.2 (2012): 347-383.

Chen, Shiyi, Hong Song, and Chenyu Wu. "Human capital investment and firms' industrial emissions: Evidence and mechanism." *Journal of Economic Behavior & Organization* 182 (2021): 162-184.

Chen, Shiyi, Tao Chen, Pingyi Lou, Hong Song, and Chenyu Wu. "Bank deregulation and corporate environmental performance." *World Development* 161 (2023): 106106.

Cherniwchan, Jevan. "Trade liberalization and the environment: Evidence from NAFTA and US manufacturing." *Journal of International Economics* 105 (2017): 130-149.

Chetty, Raj, Adam Looney, and Kory Kroft. "Salience and Taxation: Theory and Evidence." *American Economic Review* 99, no. 4 (2009): 1145–77.

Compagnie, Vincent, Kristof Struyfs, and Wouter Torsin. "Tax avoidance as an unintended consequence of environmental regulation: Evidence from the EU ETS." *Journal of Corporate Finance* 82 (2023): 102463.

Cooper, Russell, Guan Gong, and Ping Yan. "Costly labor adjustment: general equilibrium effects of China's employment regulations and financial reforms." *The Economic Journal* (2018).

Cui, Chenyu, Kose John, Jiaren Pang, and Haibin Wu. "Employment protection and corporate cash holdings: Evidence from China's labor contract law." *Journal of Banking & Finance* 92 (2018): 182-194.

Curtis, E. Mark. "Who loses under cap-and-trade programs? The labor market effects of the NOx budget trading program." *Review of Economics and Statistics* 100.1 (2018): 151-166.

Dang, Viet Anh, Ning Gao, and Tiancheng Yu. "Climate policy risk and corporate financial decisions: Evidence from the NOx budget trading program." *Management Science* 69, no. 12 (2023): 7517-7539.

Dawkins, Cedric. "Beyond wages and working conditions: A conceptualization of labor union social responsibility." *Journal of Business Ethics* 95 (2010): 129-143.

Fan, Haichao, Yichuan Hu, and Lixin Tang. "Labor costs and the adoption of robots in China." *Journal of Economic Behavior & Organization* 186 (2021): 608-631.

Fowlie, Meredith. "Emissions trading, electricity restructuring, and investment in pollution abatement." *American Economic Review* 100.3 (2010): 837-869.

Fairhurst, Douglas DJ, Yanguang Liu, and Xiaoran Ni. "Employment protection and tax aggressiveness: Evidence from wrongful discharge laws." *Journal of Banking & Finance* 119 (2020): 105907.

Gallagher, Mary, John Giles, Albert Park, and Meiyan Wang. "China's 2008 Labor Contract Law: Implementation and implications for China's workers." *Human Relations* 68, no. 2 (2015): 197-235.

Gutiérrez, Emilio, and Kensuke Teshima. "Abatement expenditures, technology choice, and environmental performance: Evidence from firm responses to import competition in Mexico." *Journal of Development Economics* 133 (2018): 264-274.

He, Guojun, Shaoda Wang, and Bing Zhang. "Watering down environmental regulation in China." *The Quarterly Journal of Economics* 135.4 (2020): 2135-2185.

Jiang, Jiaoliang, and Yulin Chen. "How does labor protection influence corporate risk-taking? Evidence from China." *Pacific-Basin Finance Journal* 68 (2021): 101572.

Jiang, Liangliang, Chen Lin, and Ping Lin. "The determinants of pollution levels: Firm-level evidence from Chinese manufacturing." *Journal of Comparative Economics* 42.1 (2014): 118-142.

Kathuria, Vinish. "Controlling water pollution in developing and transition countries—lessons from three successful cases." *Journal of Environmental Management* 78.4 (2006): 405-426.

Karplus, Valerie J., Shuang Zhang, and Douglas Almond. "Quantifying coal power plant responses to tighter SO2 emissions standards in China." *Proceedings of the National Academy of Sciences* 115, no. 27 (2018): 7004-7009.

Kong, Dongmin, and Ling Zhu. "Governments' fiscal squeeze and firms' pollution emissions: Evidence from a natural experiment in China." *Environmental and Resource Economics* 81, no. 4 (2022): 833-866.

Kugler, Adriana, and Giovanni Pica. "Effects of employment protection on worker and job flows: Evidence from the 1990 Italian reform." *Labour Economics* 15, no. 1 (2008): 78-95.

Levinson, Arik. "Technology, international trade, and pollution from US manufacturing." *American economic review* 99.5 (2009): 2177-2192.

Li, Xiaoying, and Richard B. Freeman. "How Does China's New Labour Contract Law Affect Floating Workers?." *British Journal of Industrial Relations* 53.4 (2015): 711-735.

Li, Kunming, Liting Fang, and Lerong He. "How population and energy price affect China's environmental pollution?." *Energy policy* 129 (2019): 386-396.

Li, Guangzhong, Peter H. Egger, Jie Li, and Han Wu. "Exporting firms' factor and product-quality adjustments in response to employment protection legislation: Evidence from China." *China Economic Review* 73 (2022): 101801.

Li, Jianqiang, Yaowen Shan, Gary Tian, and Xiangchao Hao. "Labor cost, government intervention, and corporate innovation: Evidence from China." *Journal of Corporate Finance* 64 (2020): 101668.

Liu, Zheng, Hongtao Shen, Michael Welker, Ning Zhang, and Yang Zhao. "Gone with the wind: An externality of earnings pressure." *Journal of Accounting and Economics* 72, no. 1 (2021a): 101403.

Liu, Mengdi, Ruipeng Tan, and Bing Zhang. "The costs of "blue sky": Environmental regulation, technology upgrading, and labor demand in China." *Journal of Development Economics* 150 (2021b): 102610.

Liu, Yun, et al. "Dark side of environmental regulation: Wage inequality cost." *Journal of Comparative Economics* 51.2 (2023): 524-544.

Mao, Jie, Chunhua Wang, and Haitao Yin. "Corporate responses to air quality regulation: Evidence from a regional environmental policy in China." *Regional Science and Urban Economics* 98 (2023): 103851.

Marciukaityte, Dalia. "Labor laws and firm performance." *Journal of Financial Research* 41.1 (2018): 5-32.

Mastrobuoni, Giovanni, and Paolo Pinotti. "Legal Status and the Criminal Activity of Immigrants." *American Economic Journal: Applied Economics* 7, no. 2 (2015): 175–206.

Messina, Julián, and Giovanna Vallanti. "Job flow dynamics and firing restrictions: evidence from Europe." *The Economic Journal* 117, no. 521 (2007): F279-F301.

Pinheiro, Rómulo, Maria Laura Frigotto, and Mitchell Young. Towards resilient organizations and societies: a cross-sectoral and multi-disciplinary perspective. Springer Nature, 2022.

Qi, Yu, Jianshun Zhang, and Jianwei Chen. "Tax incentives, environmental regulation and firms' emission reduction strategies: Evidence from China." *Journal of Environmental Economics and Management* 117 (2023): 102750.

Qiu, Yue. "Labor adjustment costs and risk management." *Journal of Financial and Quantitative Analysis* 54, no. 3 (2019): 1447-1468.

Rodrigue, Joel, Dan Sheng, and Yong Tan. "Exporting, Abatement, and Firm-Level Emissions: Evidence from China's Accession to the WTO." *Review of Economics and Statistics* (2022a): 1-45.

Rodrigue, Joel, Dan Sheng, and Yong Tan. "The curious case of the missing Chinese emissions." *Journal of the Association of Environmental and Resource Economists* 9.4 (2022b): 755-805.

Shangguan, Yiwen, and Qiyangfan Feng. "Environmental bonuses of employment protection: Evidence from labor contract law in China." *Energy Economics* 129 (2024): 107238.

Serfling, Matthew. "Firing costs and capital structure decisions." *The Journal of Finance* 71, no. 5 (2016): 2239-2286.

Shapiro, Joseph S., and Reed Walker. "Why Is Pollution from US Manufacturing Declining? the Roles of Environmental Regulation, Productivity, and Trade." *American Economic Review* 108, no. 12 (2018): 3814–54.

Simintzi, Elena, Vikrant Vig, and Paolo Volpin. "Labor protection and leverage." *The Review of Financial Studies* 28, no. 2 (2015): 561-591.

Sobczak, André, and Christelle Havard. "Stakeholders' influence on French Unions' CSR strategies." *Journal of Business Ethics* 129 (2015): 311-324.

Thatchenkery, Sruthi, and Riitta Katila. "Innovation and profitability following antitrust intervention against a dominant platform: The wild, wild west?." *Strategic Management Journal* 44.4 (2023): 943-976.

Wang, Hua, and David Wheeler. Endogenous enforcement and effectiveness of China's pollution levy system. Vol. 2336. World Bank Publications, 2000.

Xu, Qiping, and Taehyun Kim. "Financial constraints and corporate environmental policies." *The Review of Financial Studies* 35.2 (2022): 576-635.

Figures and Tables

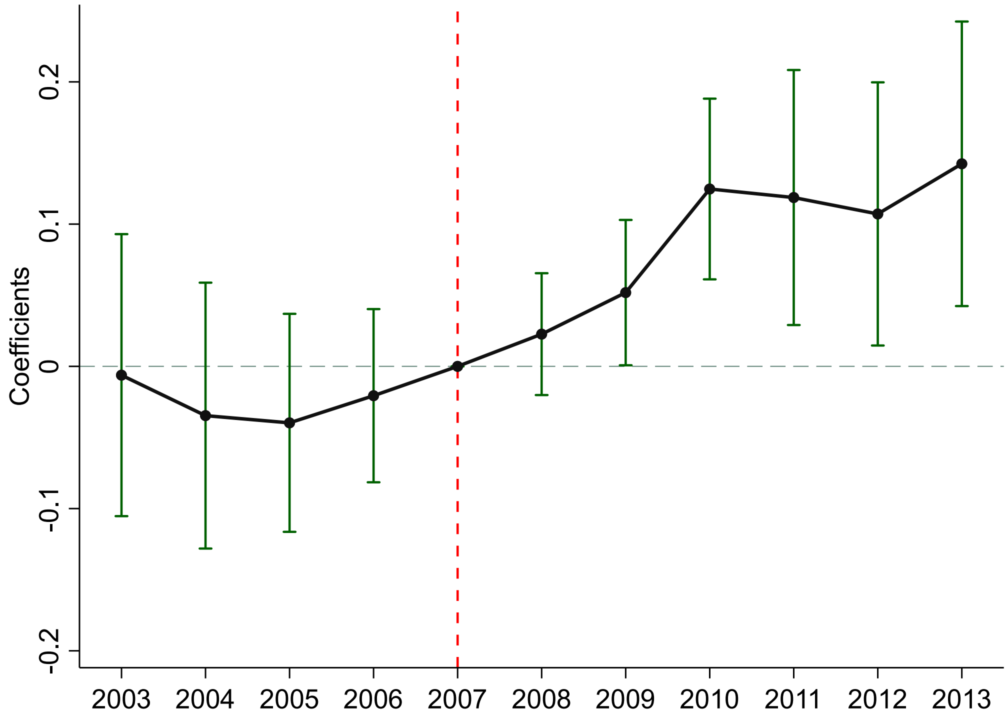

Figure 1 The Dynamic Effects on Pollution Emission Intensity

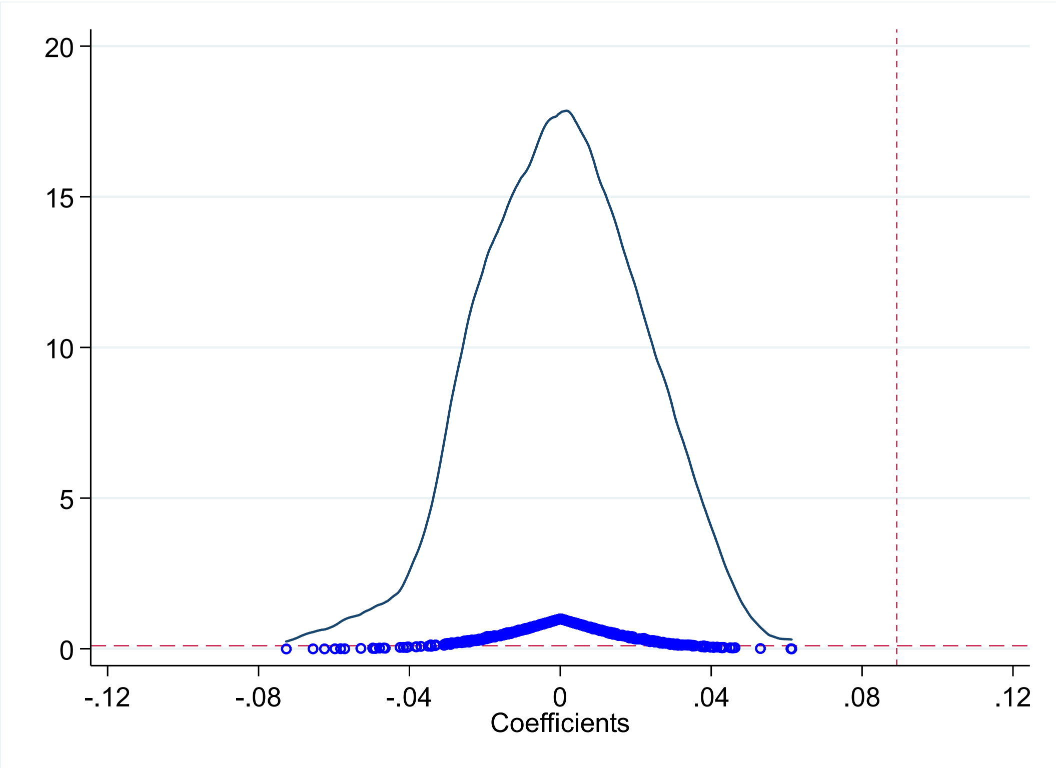

Figure 2 Permutation Test

Table 1 Summary Statistics

Variables	Definition	Mean	S.D.	P25	Median	P75
COD Intensity (kg/10k yuan)	COD emission / total output	8.224	23.893	0.189	0.930	4.810
Total output (10k yuan)	Industrial output value	23304.2	88888.7	2000	5500	16690
Ln(COD)	Ln(COD emission intensity)	-0.066	2.285	-1.664	-0.073	1.571
Labor intensity	Employee size / fixed assets	0.254	0.384	0.068	0.133	0.273
Firm size (10k yuan)	Ln(total assets)	8.932	1.501	7.818	8.840	9.955
Debt Ratio	Total liabilities / total assets	0.572	0.253	0.392	0.579	0.754
Fixed Assets	Net fixed assets / total assets	0.366	0.194	0.214	0.343	0.497
Export	Value of export / total sales	0.143	0.298	0.000	0.000	0.057

Table 2 Results for Baseline Regression

Variables	Ln(COD Emission Intensity)			
	(1)	(2)	(3)	(4)
Labor Intensity × *Post*	0.114***	0.112***	0.083***	0.089***
		(0.023)	(0.023)	(0.023)
Firm Size		-0.074***	-0.073***	-0.073***
		(0.013)	(0.013)	(0.013)
Debt Ratio		0.052*	0.047	0.047*
		(0.028)	(0.028)	(0.028)
Fixed Assets		0.178***	0.184***	0.174***
		(0.036)	(0.036)	(0.036)
Export		-0.049**	-0.063***	-0.062***
		(0.021)	(0.021)	(0.022)
Constants	-0.082***	0.491***	0.487***	0.493***
	(0.003)	(0.118)	(0.118)	(0.117)
Firm-fixed	Yes	Yes	Yes	Yes
Industry-year fixed	Yes	Yes	No	Yes
Province-year fixed	No	No	Yes	Yes
Observations	176,494	176,494	176,494	176,494
Adjusted-R^2	0.715	0.715	0.717	0.719

Note: The dependent variable is the intensity of Chemical Oxygen Demand (COD) emitted by firms, which is calculated as the COD emissions divided by the firm's total output value. *Labor Intensity* is baseline firm-level labor intensity, which is calculated as the ratio of the number of employees within a firm at the end of 2007 over its fixed assets. *Post* is a dummy variable that equals to one for the period of 2008-2013 and zero for the priod of 2003-2007. Standard errors in parentheses are clustered at the firm level. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 3 Result for PSM-DID

Variables	Ln(COD Emission Intensity)		
	(1)	(2)	(3)
High Labor Intensity × *Post*	0.049**	0.064***	0.074***
	(0.022)	(0.021)	(0.020)
Controls	Yes	Yes	Yes
Firm-fixed effect	Yes	Yes	Yes
Industry-year fixed effect	Yes	Yes	Yes
Province-year fixed effect	Yes	Yes	Yes
Observations	131,524	145,623	153,653
Adjusted R^2	0.714	0.716	0.717

Note: The propensity score matching was conducted using the nearest neighbor matching algorithm, with treatment and control group enterprises matched on a period-by-period basis. Columns (1)-(3) respectively employ nearest neighbor matching algorithms with ratios of 1:4, 1:6, and 1:8. *High Labor Intensity* represents a dummy variable based on labor intensity. If a firm's labor intensity at the end of 2007 is larger than the median of the distribution, *High Labor Intensity* is assigned a value of 1; otherwise, it is set to 0. Standard errors in parentheses are clustered at the firm level. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4 Robustness Check: Alternative variables for pollution emission

Variables	Sulfur Dioxide	Wastewater	Ammonia Nitrogen
	(1)	（3）	（3）
Labor Intensity × *Post*	0.041	0.070***	0.129***
	(0.041)	(0.020)	(0.044)
Controls	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes
Industry-year fixed effects	Yes	Yes	Yes
Province-year fixed effects	Yes	Yes	Yes
Observations	138,347	176,107	142,326
Adjusted-R^2	0.779	0.731	0.598

Note: The dependent variables in the table all represent the natural logarithm of the respective pollutant emission intensities. *Labor Intensity* is firm-level labor intensity, which is calculated as the ratio of the number of employees within a firm at the end of 2007 to its fixed assets. *Post* is a dummy variable, which equals to one for year 2008-2013 and zero for year 2003-2007. Standard errors in parentheses are clustered at the firm level. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 5 Robustness Check: alternative measures for treatment variables

Variables	Ln(COD Emission Intensity)	
	(1)	(2)
High Labor Intensity × Post	0.098***	
	(0.019)	
2003-07 Averaged Labor Intensity × Post		0.139***
		(0.032)
Controls	Yes	Yes
Firm-fixed	Yes	Yes
Industry-year fixed	Yes	Yes
Province-year fixed	Yes	Yes
Observations	176,494	172,544
Adjusted-R^2	0.719	0.718

Note: *High Labor Intensity* serves as a binary variable which equals one if a given firm's labor intensity exceeded the median of the distribution, and zero otherwise. *2003-07 Averaged Labor Intensity* is indicative of a firm's average labor intensity spanning the years 2003 to 2007. *Post* is a dummy variable, which equals to one for year 2008-2013 and zero for year 2003-2007. Standard errors in parentheses are clustered at the firm level. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 6 Robustness Check: Excluding the Impact of 2008 Financial Crisis

Variables	Ln(COD Emission Intensity)			
	(1)	(2)	(3)	(4)
Labor Intensity × Post	0.087***	0.083***	0.113***	0.072***
	(0.023)	(0.023)	(0.027)	(0.022)
Leverage × Post	-0.017			
	(0.019)			
Trade × Post		-0.056***		
		(0.020)		
Labor Intensity × Financial Crisis Year			-0.076***	
			(0.025)	
Labor Intensity × Post Stimulus				0.060
				(0.039)
Controls	Yes	Yes	Yes	Yes
Firm-fixed	Yes	Yes	Yes	Yes
Industry-year fixed	Yes	Yes	Yes	Yes
Province-year fixed	Yes	Yes	Yes	Yes
Observations	168,208	168,208	176,494	176,494
Adjusted-R^2	0.720	0.720	0.719	0.719

Note: The dependent variable is the intensity of Chemical Oxygen Demand (COD) emitted by firms, which is calculated as the COD emissions divided by the firm's total output value. *Labor Intensity* is firm-level labor intensity, which is calculated as the ratio of the number of employees within a firm at the end of 2007 to its fixed assets. *Leverage* is a dummy variable that equals one if the firm's financial leverage is above the median of its distribution and zeros otherwise. *Trade* is a dummy variable if the firm had exported goods in 2007 and zero otherwise. *Post* is a dummy variable, which equals to one for year 2008-2013 and zero for year 2003-2007. *Financial Crisis* is a dummy variable, which is equal to one for the year 2008 and zero otherwise. *Post Stimulus* is a dummy variable, which is designated as one for the year 2011-2013 and zero otherwise. Standard errors in parentheses are clustered at the firm level. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 7 Heterogeneous Analysis

Variables	Panel A: Ownership SOE (1)	Panel A: Ownership Non-SOE (2)	Panel B: Environmental Regulation Strong (3)	Panel B: Environmental Regulation Weak (4)	Panel C: Financial Constraint Lax (5)	Panel C: Financial Constraint Tight (6)
Labor Intensity ×Post	-0.050	0.083***	0.050	0.098***	0.033	0.095***
	(0.094)	(0.032)	(0.031)	(0.037)	(0.036)	(0.033)
Control	Yes	Yes	Yes	Yes	Yes	Yes
Firm-fixed	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year fixed	Yes	Yes	Yes	Yes	Yes	Yes
Province-year fixed	Yes	Yes	Yes	Yes	Yes	Yes
p-value (H_0: $\boldsymbol{\alpha_1}^{(1)} \geq \boldsymbol{\alpha_1}^{(2)}$)	0.088					
p-value (H_0: $\boldsymbol{\alpha_1}^{(3)} \geq \boldsymbol{\alpha_1}^{(4)}$)			0.096			
p-value (H_0: $\boldsymbol{\alpha_1}^{(5)} \geq \boldsymbol{\alpha_1}^{(6)}$)					0.002	
Observations	16,365	116,118	77,895	77,484	76,847	76,715
Adjusted R^2	0.705	0.718	0.728	0.714	0.738	0.702

Note: the subscription of α_1 denotes the regression coefficient for corresponding models. For example, $\alpha_1^{(1)}$ represents the coefficient of the regression for the SOE subsample. p-value (H_0: $\alpha_1^{(1)} \geq \alpha_1^{(2)}$) denotes the one-sided p-values for testing the regression coefficient in column (1) and (2). Similarly, other p-values follow suit in a sequential manner.

Table 8 Impact of Labor Contract Law on Firm's Operating Leverage

Variables	%Δ(EBIT)		
	Full sample	Treatment group	Control group
	(1)	(2)	(3)
%ΔSales × Post	0.151***	0.256***	0.069
	(0.057)	(0.088)	(0.076)
%ΔSales	0.885***	0.894***	0.870***
	(0.046)	(0.072)	(0.060)
Controls	Yes	Yes	Yes
Firm-fixed	Yes	Yes	Yes
Industry-year fixed	Yes	Yes	Yes
Province-year fixed	Yes	Yes	Yes
Observations	139,324	62,744	76,571
Adjusted R^2	0.062	0.059	0.065

Note: The dependent variable $\%\Delta EBIT_{it}$ is the percentage change in a firm's earnings before interest and taxes (EBIT). $\%\Delta Sales_{it}$ is the percentage change in a firm's total sales revenue. *Post* is a dummy variable, which equals to one for year 2008-2013 and zero for year 2003-2007. Standard errors in parentheses are clustered at the firm level. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 9 Pollution Abatement Actions

	(1)	(2)	(3)	(4)
	End of Pipe		Production process	
Variables	Treatment Capacity	# of Treatment Facility	Water Input	Green Innovation
Labor Intensity × Post	-163.929***	0.004	0.063***	-0.012***
	(48.885)	(0.009)	(0.019)	(0.001)
Controls	Yes	Yes	Yes	Yes
Firm-fixed	Yes	Yes	Yes	Yes
Industry-year fixed	Yes	Yes	Yes	Yes
Province-year fixed	Yes	Yes	Yes	Yes
Observations	144,513	144,352	176,440	176,488
Adjusted R^2	0.761	0.615	0.784	0.426

Note: In column (1), the dependent variable is the the firm's maximum treatment capacity on wastewater (tons/day). In column (2), the dependent variable is the number of wastewater abatement facilities. In column (3), the dependent variable is input of fresh water, measured as fresh water consumption per unit of output during the manufacturing process (with log transformation). In column (4), the dependent variable is green patent, measured as the number of green patent applications plus one (with log transformation). *Labor Intensity* is firm-level labor intensity, which is calculated as the ratio of the number of employees within a firm at the end of 2007 to its fixed assets. *Post* is a dummy variable, which equals to one for year 2008-2013 and zero for year 2003-2007. Standard errors in parentheses are clustered at the firm level. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Appendix A:

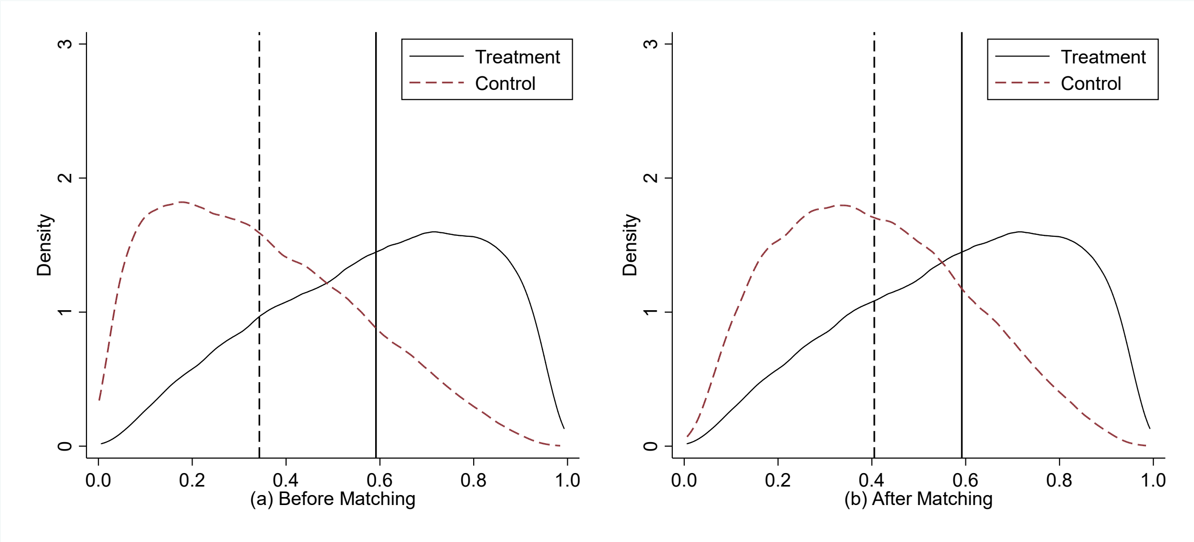

Figure A1: The Distribution of Propensity Score before and after Matching

Note: The figure on the left shows the distribution of propensity scores prior to matching, while the figure on the right presents the distribution following the matching process. In each figure, the horizontal axis corresponds to the propensity scores, and the vertical axis reflects the kernel density. The solid vertical line marks the average propensity score for the treatment group, whereas the dashed vertical line indicates the average score for the control group.

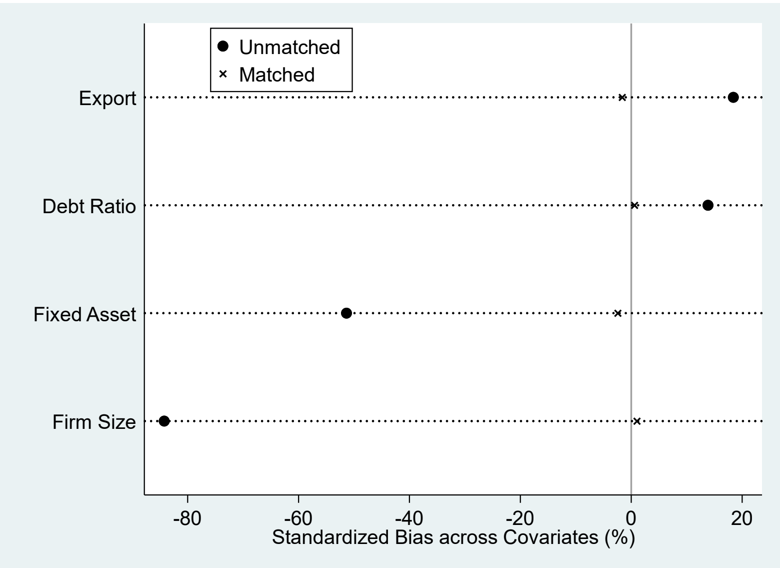

Figure A2: Comparison of standardized difference between unmatched and matched covariates