Minimum Wages, State Ownership, and Corporate Environmental Policies*

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ABSTRACT

This study examines how minimum wage hikes affect firms' industrial pollution. Using the establishment-level pollutant emission data on Chinese industrial firms and exploring the minimum wage policy discontinuities at county borders, we find that minimum wage hikes induce firms to pollute more and reduce their abatement efforts. In particular, a 10% increase in minimum wage corresponds to a 4.63% increase in COD emissions. State ownership mitigates the negative impact of minimum wages on pollutant emissions, suggesting its role in addressing externality. The effects of minimum wages on pollutant emissions are stronger for financially constrained firms and firms with lower product market power, and higher labor intensity. These effects are attenuated with the staggered increase of pollution fee charges across provinces. Overall, our findings highlight the unintended environmental consequences of labor market policies.

Keywords: minimum wages, state ownership, environmental externality, geographical discontinuity

JEL Classification: G32, H23, J31, J38, Q56

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I. Introduction

To reduce rising income inequality, minimum wage policies have been adopted in around 90% of countries worldwide (International Labour Organization, 2020). Further, public support for an increase in the minimum wages has recently been growing globally.[1] On the one hand, opponents argue that the minimum wage causes job losses and fails to target those it aims to help (e.g., Stigler 1946; Brown, 1988; Neumark and Wascher, 2010; Jardim et al., 2018). On the other hand, more recent research has even found negligible employment effects of minimum wages (e.g., Card, 1992; Card and Krueger, 1994; Dube, Lester, and Reich, 2010; Cengiz et al., 2019). Further, while the minimum wage raises may reduce income inequality, it is unclear who pays for the cost of minimum wage hikes. Studies suggest that raises in minimum wages can harm the intended beneficiaries by price pass-through to low-income households and non-cash compensation reduction for employees (e.g., MaCurdy, 2015; Clemens, Kahan, and Meer, 2018; Dube and Lindner, 2021; Dustmann et al., 2021; Manning, 2021). However, the environmental costs of minimum wages have received little attention.

Extending the recent literature on firms' responses to minimum wages (e.g., Hau, Huang, and Wang, 2020; Agarwal, Ayyagari, and Kosová, 2022; Gustafson and Kotter, 2022), we examine the impact of the minimum wages on firms' environmental policies, especially when environmental regulations are not binding. In China, the water and air pollution led to a severe burden of the public health system, costing the nation 2% of its rural gross domestic product from diseases (Guan et al., 2016). Zhang et al. (2010) estimated that these environmental risks contributed to around 2.5 million premature deaths every year from cardiopulmonary and

[1] For example, most EU member states have increased their statutory minimum wages, with some raising their rates by more than 10% (Vacas-Soriano and Kostolny, 2022). A recent poll by Pew Research found 67% of Americans support a USD 15/hour federal minimum wage (Davis and Hartig, 2019). Policymakers in several states have enacted laws that will eventually raise their state's minimum wages to USD 15/hour. For example, *the Raise the Wage Act* in 2019 stipulated that the federal minimum wage will be increased to USD 15/hour by 2025. Although hourly minimum wages are targeted at workers in the leisure and hospitality industries, manufacturing firms are also affected by the (monthly) minimum wage hikes (e.g., Otto Motors, 2017; Harasztosi and Lindner, 2019; Hau, Huang, and Wang, 2020).

gastrointestinal diseases, cancers, and other diseases or injuries. Many of these are associated with industrial and microbial pollutants. Industrial firms in China partially internalize the environmental costs and take their environmental actions. Pollution abatement, which requires substantial inputs of energy, labor, and contractual services, is extraordinarily expensive. Hence, firms actively adjust their environmental policies by trading off the abatement costs and labor costs following the minimum wage hikes. Therefore, it is of high significance to understand how firms respond to minimum wage hikes when formulating environmental policies.

How minimum wage hikes affect firms' industrial pollution remains unclear. On the one hand, minimum wage hikes represent competitive shocks to firms, if their competitors locate in areas where the labor costs are relatively low. From a "Darwinian" view of competition, the increased labor costs shocks may reduce firm value and profitability, and potentially cause firms that were close to the profit margin to exit the market (Luca and Luca, 2019). Accordingly, the increased competitive shocks may lead to firm exit and reduce industrial pollution. Moreover, in order to cope with the increased competitive pressure, firms could reduce high-polluting low-profit production to raise firm productivity, thereby leading to a cleaner production process. Also, firms could shift high-polluting low-profit production into establishments in regions or even foreign countries with lower labor costs in response to minimum wage hikes (e.g., Fan, Lin, and Tang, 2018; Chen et al., 2022). Therefore, minimum wage hikes may lead to lower industrial pollution both at the firm level and at the regional level.

On the other hand, firms may shift the increased labor costs to stakeholders. Firms may reduce employment, adjust the non-cash compensation (e.g., insurance) of employees, or transmit the costs to consumers by raising prices (MaCurdy, 2015; Clemens, Kahn, and Meer, 2018; Harasztosi and Lindner, 2019). Also, firms could adjust their corporate policies in response to the increased labor costs. For example, firms may cut their capital expenditure or reduce the service quality when minimum wage increases (Agarwal, Ayyagari, and Kosova, 2022; Gustafson and Kotter, 2022). The manufacturing firms in our sample produce tradeable products, making it difficult to pass the increased labor costs on to consumers (Hau, Huang, and Wang, 2020). Given the difficulty in transferring costs to consumers and the low pollution discharge fees, manufacturing firms in China may not have the incentives to limit their industrial pollution.[2]

Although firms may pass their labor costs onto the environment by increasing pollutant emissions, firms with and without state ownership may respond differently. State-owned enterprises (SOEs) often receive criticism for their low efficiency and productivity, and privatization may improve financial performance through better corporate governance and technological transformation (e.g., Shleifer, 1998; Megginson and Netter, 2001). Despite their relatively poorer financial performance, some studies argue that SOEs may be valuable for other tasks (e.g., Stiglitz, 1993; Bai et al., 2000; Xu, 2011). For example, state ownership can act in the public interest to address environmental issues (e.g., Besley and Ghatak, 2001; Hsu, Liang, and Matos, 2021). Given that SOEs are created to deal with market failures and externalities, we thus expect SOEs and non-SOEs to carry out different environmental actions when facing the increased labor costs induced by minimum wage raises. Therefore, coexistence of SOEs and non-SOEs in various regions and industries across China provides an ideal setting to explore how different ownership types moderate the role of minimum wages in shaping firms' environmental policies. Indeed, throughout our sample period from 1998 to 2013, the 180,976 SOEs in China accounted for over one-quarter of the total industrial output.

[2] *The China News* reported that many firms would rather pay for the pollution discharge fees than invest in abatement facilities to remove pollutants (https://www.chinanews.com.cn/ny/2014/11-06/6759131.shtml). The government officials from Beijing Environmental Protection Bureau argued that the pollution discharge fees in 2013 were too low to motivate firms to reduce pollution (*China National Radio*, http://news.cnr.cn/native/city/201312/t20131214_514401554.shtml).

Empirically identifying the causal effects of minimum wages on firms' environmental policies involves endogeneity concerns since minimum wages are set based on local economic conditions. To overcome the concern that local minimum wages may not be orthogonal to economic fundamentals, we exploit the changes in minimum wages at county borders (Holmes, 1998; Dube, Lester, and Reich, 2010). Such a research design that compares the environmental actions of geographically proximate firms in neighboring county pairs with different minimum wages mitigates the concern that local economic conditions may drive our results. To implement this identification strategy, we construct all contiguous county pairs in China. We restrict firms within certain distances from the shared border (i.e., 5 km, 10 km, and 15 km) to ensure the firms from neighboring counties are indeed comparable. We then add various firm-level and local economic variables known to affect minimum wages and pollutant emissions as controls. Moreover, we include firm and county pair fixed effects to control for firm- and region-specific characteristics. Since minimum wage policies are determined at the province level and many provincial policies influence both minimum wages and pollutant emissions simultaneously, we include province-year fixed effects. Finally, as industrial trends (e.g., technological advancement) may also drive the relationship between minimum wages and pollutant emissions, we include industry-year fixed effects.

To study the empirical relation between minimum wage hikes and firms' environmental actions, we obtain pollutant emission data from China's Environmental Survey and Reporting (ESR) database and financial information from the Chinese Industrial Census (CIC) from 1998 to 2013.[3] Following He, Wang, and Zhang (2021), we measure a firm's environmental

[3] We use minimum wage hikes in China to examine the impact of increased labor costs on industrial firms' environmental policies. The sample of Chinese industrial firms is suitable for this analysis for the following reasons. First, in the United States, hourly minimum wages are targeted at employees working at the retail sector (e.g., Addison, Blackburn, and Cotti, 2009; MaCurdy, 2015). It is thus difficult to evaluate the effect of minimum wages on industrial firms' environmental pollution. By contrast, minimum monthly wages in China have been shown to affect manufacturing firms substantially (Hau, Huang and Wang, 2020). Second, the ESR database provides pollutant emission data for over 420,000 firms across around 3000 counties from year 1998 to 2013.

performance by its chemical oxygen demand (COD) emission, a key indicator of water pollution. We examine the impact of a minimum wage policy on firms' environmental performance in two steps. First, we investigate the effects of minimum wage hikes on firms' labor costs. We find that firms' average wage rises with an increase in the minimum wage. Second, we estimate the impact of minimum wage hikes on firms' environmental performance. We find that firms in regions with higher minimum wages pollute more. Our baseline analysis reveals that a 10% increase in minimum wages leads to a 4.63% increase in COD emissions in the following year. The effects of the minimum wage increase on firms' average wage and environmental performance are robust to the inclusion of a wide set of control variables, including size, profitability, leverage, total output, GDP per capita, and GDP growth. Collectively, our study provides important evidence for the policy debate over raising minimum wages globally.

We conduct several robustness checks. First, following He, Wang, and Zhang (2021) and Liu et al. (2021), we use several other pollution outcomes to measure a firm's environmental performance. To mitigate the concern that an increase in firms' production drives our results on COD emissions, we examine the effects of minimum wages on COD removal. We find that minimum wage hikes lead to less COD removal. Besides COD emissions, our data also cover firms' emissions of sulfur dioxide (SO_2), ammonia nitrogen (NH_3-N), and nitrogen oxide (NO_x) as well as industrial gas discharge. Consistent with our predictions, our analyses suggest that an increase in the minimum wage is associated with higher SO_2 and NH_3-N emissions as well as higher industrial gas discharge.

We further investigate the role of state ownership in the relationship between minimum wages and firms' environmental performance. We find that the effects of minimum wages on

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This plant-level emission data with rich geographical information allows us to examine the effects of minimum wages on industrial pollution.

firms' pollutant emissions are statistically significantly positive for non-SOEs. By contrast, the effects are much weaker or even not statistically significant for SOEs. This finding supports the social view of state ownership that SOEs are better at dealing with market failures and externalities such as employment and environmental issues (e.g., Stiglitz, 1993; Bai et al., 2000; Besley and Ghatak, 2001).

After establishing the link between the minimum wage policy and firms' environmental performance and the role of state ownership, we further explore the underlying mechanisms. Firms could make "end-of-pipe" adjustments to remove pollutants and reduce emissions. However, the competitive shocks from minimum wage hikes may limit their ability to invest in pollution abatement facilities. Indeed, we find that firms facing higher minimum wages do not invest as much in pollution abatement as other firms. Moreover, the effect is more pronounced for non-SOEs, which explains the environmental performance gap between SOEs and non-SOEs.

We next attempt to triangulate our main findings through cross-sectional analyses. First, firms with greater product market power may have a greater ability to pass their labor costs onto their downstream customers or consumers. Therefore, these firms are less likely to pass the labor costs from minimum wage raises onto the environment by increasing pollutant emissions. Consistent with this prediction, we find that the effects of minimum wages on firms' environmental performance are weaker for firms with greater product market power, as measured by the industry-wide Lerner Index. Second, firms' sensitivity to minimum wages may affect their environmental response. We find that firms with higher labor intensity and lower average wage are more responsive to minimum wages and pollute more. Third, financially constrained firms may increase pollutant emissions as firms balance abatement costs and potential legal liabilities (e.g., Hong, Kubik, and Scheinkman, 2012; Cheng, Hong, and Shue, 2013; Xu and Kim, 2020). Therefore, we test whether the relationship between minimum wages and firms' pollutant emissions varies across firms with different financial conditions. We find that the effects of minimum wages on firms' pollutant emissions are more pronounced for financially constrained firms.

Lastly, we examine firms' environmental response to an exogenous increase in pollution discharge fees, which are set to motivate firms to internalize pollution abatement costs. Firms thus trade off pollution discharge fees and abatement costs. When pollution charges are higher than marginal abatement costs, firms may reduce pollutant emissions to minimize the incurred costs. However, in China, pollution discharge fees have historically been lower than the abatement costs, and firms benefit economically from paying pollution charges instead of investing in abatement facilities. The increase in discharge fees thus offers an opportunity to exploit the variations in COD and SO_2 charges across provinces and years to test whether the relationship between minimum wages and firms' pollutant emissions is conditional on pollution discharge fees. We find that firms with higher COD and SO_2 charges are less likely to transfer labor costs onto the environment by increasing pollutant emissions, highlighting the effectiveness of pollution charges for environmental governance.

Besides our analyses of individual firms, we also examine the aggregate impact of minimum wages on regional pollutant emissions. We find that minimum wage hikes lead to higher county-level pollution and that the effect is weaker in counties with a higher percentage of SOEs. Moreover, we are also interested in the costs incurred when SOEs internalize the increased labor costs. We find that the average profitability of firms is lower for counties with higher minimum wages and that emission constraints by SOEs lower their financial performance.

Our study contributes to several streams of the literature. First, we contribute to the burgeoning literature on the social welfare effects of minimum wages (Dettling and Hsu, 2021).

Although the debate on minimum wage policies primarily focuses on employment losses (e.g., Card and Krueger, 1995), some recent research argues that to evaluate the policy, empirical research shall also reveal the social costs of minimum wages (Dube and Linder, 2021; Manning, 2021; Asai and Inatani, 2022). Clemens (2021) argues that a minimum wage policy can harm its intended beneficiaries by price pass-through to consumers and non-cash compensation reduction for employees. MaCurdy (2015) documents that low-income households may bear the cost of minimum wages, as these households may purchase goods and services produced by minimum wage labor. Clemens, Kahn, and Meer (2018) find that state-level minimum wages decrease the likelihood of employer-sponsored health insurance being provided to employees. Minimum wages may also reduce firms' market value (Draca, Machin, and Van Reenen, 2011; Bell and Machin, 2018) and operating profits (Gan, Hernandez, and Ma, 2016; Harasztosi and Lindner, 2019; Drucker, Mazirov, and Neumark, 2021; Agarwal, Ayyagari, and Kosová, 2022). In addition, firms may change their capital expenditure in response to minimum wage hikes (Geng et al., 2021; Gustafson and Kotter, 2022). However, little is known about whether firms pass a proportion of the increased labor costs on to the environment by decreasing pollutant abatement efforts. We therefore document the unintended environmental consequences of minimum wages.[4]

Second, our findings add to the burgeoning literature on the effects of labor-market conditions on corporate policies. For example, Agrawal and Matsa (2013) find that firms'

[4] Our study also reveals the unintended consequences of the minimum wage policy (i.e., a non-climate policy). Existing studies focus on the effects of climate policies, financial tools in controlling pollutant emissions, and investors' reaction to toxic emissions (e.g., Henderson, 1996; Greenstone, 2002; Bushnell et al., 2017; Hong, Karolyi, and Scheinkman, 2020; Krueger, Sautner, and Starks, 2020; Bolton and Kacperczyk, 2021). Akey and Appel (2021) find that the Comprehensive Environmental Response, Compensation, and Liability Act limits firms' pollutant emission by imposing the ex post liability on parent firms. Bartram, Hou, and Kim (2021) show that the cap-and-trade program in California leads firms to shift their production and emissions to unregulated states. Flammer (2021) documents that green bond issuers reduce their CO_2 emissions and achieve high environmental ratings. Krueger, Sautner, and Starks (2020) and Bolton and Kacperczyk (2021) show the existence of climate risks premium in stock markets. However, the coordination among policies is of vital importance in combating climate risks and protecting the environment. Our study highlights the role of non-environmental policies in firms' environmental performance (Bellon, 2021).

financing decisions depend on state-level unemployment policies. Simintzi, Vig, and Volpin (2015) and Serfling (2016) show that firms reduce their leverage due to increased firing frictions. Liu et al. (2022) find that firms use non-wage benefits to increase gender diversity by attracting women. In addition, studies examine how labor policies affect firm capital expenditures (Autor, Kerr, and Kugler, 2007, Bai, Fairhurst, and Serfling, 2020), M&A activities (John, Knyazeva, and Knyazeva, 2015, Dessaint, Golubov, and Volpin, 2017), household spending (Aaronson, Agarwal, and French, 2012; Dettling and Hsu, 2021), and innovation (Acharya, Baghai, and Subramanian, 2014; Gao, Hsu, and Zhang, 2021). Our study adds to the discussion on how labor market policies are associated with corporate policies.

Third, we contribute to the literature on the controversy of state ownership. On the one hand, SOEs are viewed as having weak corporate governance and poor financial performance (Megginson, Nash, and Van Randenborgh, 1994; Megginson and Netter, 2001; Bortolotti and Faccio, 2009). On the other hand, researchers argue that SOEs are created for strategic purposes and are more responsible for social welfare than non-SOEs (Stiglitz, 1993; Bai et al., 2000; Xu, 2011). For example, Karolyi and Liao (2017) document the growing cross-border acquisition activities by SOEs from autocratic countries targeting natural resource sectors. Hsu, Liang, and Wang (2021) show that SOEs are more responsive to sustainability issues in the international context. Our findings support the social view of SOEs by showing that they are less likely to pass their increased labor costs onto the environment by increasing pollutant emissions relative to non-SOEs. In other words, SOEs partly internalize the increased labor costs and absorb the environmental externalities.

The rest of this paper is organized as follows. Section II describes the data, sample construction, and summary statistics. Section III presents the empirical design and the results on the effects of minimum wages on firms' pollution emissions, robustness checks, the heterogeneous analyses, and the aggregate impact of minimum wage on county-level environmental and financial performance. Section IV concludes.

II. Data and Summary Statistics

In this section, we describe the datasets, sample construction, and descriptive statistics. We used three datasets: (1) firm-level emission and financial data, (2) county-level minimum wage data, and (3) county border map data.

2.1 Firm-level Emission and Financial Data

To measure the firm's pollutant emissions, we use China's Environmental Survey and Reporting (ESR) database maintained by the Ministry of Environmental Protection and the National Bureau of Statistics. The ESR database is the most comprehensive dataset on industrial pollution in China and is used by the government to monitor the polluting activities of industrial firms. Firms' inclusion in the ESR database depends on their chemical oxygen demand (COD) emission and sulfur dioxide (SO_2) emission rankings. Firms with higher ranks (i.e., higher pollutant emissions), which jointly contributed for 85% of all the emissions in one county, are covered by the ESR database (He, Wang, and Zhang, 2021). Our sample period goes from 1998 to 2013. Each year, firms first self-report their pollution information and then the numbers are randomly checked by local Environmental Protection Bureaus. Like the Toxic Release Inventory (TRI) database for the U.S. plants, ESR data cannot be used in environmental penalty decisions except for cases of misreporting; this alleviates the concern that firms may underreport their pollution numbers to avoid regulatory punishment.

The ESR database provides information on firms' pollutant emissions, industrial output, and abatement efforts. It covers emissions of several pollutants, including chemical oxygen demand (COD), sulfur dioxide (SO_2), ammonia nitrogen (NH_3-N), nitrogen oxide (NO_x), and industrial gas discharge. Following He, Wang, Zhang (2021) and He, Xie, and Zhang (2020), we use COD emissions as our primary measure of a firm's pollutant emissions for two reasons. First, the central government always sets COD emission targets in its five-year plans,[5] as such emissions are the primary indicator to evaluate the environmental performance of local governments. Second, COD emissions are prevalent in most polluting industries, while other pollutants (e.g., NO_x) may be concentrated in specific industries (e.g., the petrochemical industry). We use the natural logarithm of one plus the COD emissions in kilograms to measure a firm's pollution emissions.[6]

In addition to pollutant emissions, the ESR database documents the number of pollutant treatment facilities owned by a firm and a firm's pollutant treatment capacity. We scale the number of treatment facilities and a firm's treatment capacity by its industrial output to measure the extent to which its intervention investment meets production requirements. Since our primary pollution metric (COD emissions) measures water pollution, we focus on a firm's wastewater treatment capacity and wastewater treatment facilities.

Besides taking pollution information from the ESR database, we obtain firms' financial information for 1998 to 2013 from the Chinese Industrial Census (CIC) data maintained by the National Bureau of Statistics. The CIC database covers all industrial firms with annual sales of more than RMB 5 million (about USD 700,000) until 2009 and RMB 20 million (about USD 3 million) thereafter.[7] For each firm year, we have a firm's size, leverage, profitability, total

[5] For example, in the 10th and 11th Five-Year Plans for National Environmental Protection (2001–2005 and 2006–2010, respectively), the central government targeted reducing total COD emissions by 10% in each period. In the 12th Five-Year Plan for National Environmental Protection (2011–2015), COD is listed as the most important performance indicator of environmental protection. In terms of environmental hazards, a higher COD level is associated with a greater amount of oxidizable organic material, which reduces dissolved oxygen levels.

[6] Following Liu et al. (2021), we also used the SO_2 emission, NH_3-N emission as well as industrial gas discharge for a robustness check and found similar results.

[7] Many variables in the 2010 CIC dataset are missing. We obtain Bureau van Dijk's (BvD) data to back out the financial information to overcome this issue. Since BvD records numbers in USD, we use the official historical average USD/RMB exchange rates to convert them into RMB. This allows us to uncover financial information for 310,000 CIC firms in 2010.

wage bill, number of employees, ownership type, and address. To address the outliers in the dataset, we winsorized all the financial variables by 0.1% at both ends.

We match firms in ESR and CIC by their organization codes and firm names. For each ESR firm in each year, we match a CIC firm with the same organization code in the same year. We then match a CIC firm with the same firm name for the remaining unmatched ESR firms. After matching, we obtain a sample of 695,741 firm-year observations with 182,178 unique firms from 1998 to 2013. Throughout our sample period, the ESR–CIC matched sample comprises about 73% of the total industrial output of all the firms in the ESR database. See Figure A1 in the internet appendix for the total industrial output over the years for the ESR and ESR–CIC matched samples.

2.2 County-level Minimum Wage Data

China's minimum wage policies were first approved in 1993 and its minimum wage system came into force after the promulgation of a new labor law a year later. This was a milestone in China's labor administration development (Casale and Zhu, 2013). The new labor law provided a legal framework for governing the labor market, which included a minimum wage fixing mechanism for China's workforce. According to Article 48 of the labor law (1994), minimum wages are stipulated by the governments of the country's provinces, autonomous regions, and municipalities and reported to the State Council.[8] The administrative departments of labor and social security in each province are responsible for setting the local minimum wage in accordance with its local conditions (e.g., the minimum cost of living, average wage, and labor productivity). The minimum wage varies substantially across cities and counties

[8] See the Labor Law (1994) of the People's Republic of China at http://www.gov.cn/banshi/2005-05/25/content_905.htm.

within the same province. For example, in 2011, there were 108 minimum wages across Mainland China.

Our county-level minimum wage data are obtained by combining the three datasets from the Ministry of Human Resources and Social Security, China Research Data Services, and China Open. A manual check shows that the minimum wages in the three datasets are consistent. Our minimum wage dataset covers the minimum wages of 2,852 counties from 1998 to 2013. The average minimum wage increases substantially during our sample period. In 1998, the average minimum monthly wage was around RMB 200, which increased to RMB 1,100 in 2013. The average annual increase is around 12%. More than 45% of county–years have a minimum wage increase of over 10% from the previous year. Figure 1 displays the geographic distribution of minimum wages across counties in 2000, 2005, and 2010. As shown in Figure 1, many neighboring counties have different minimum wages, with 60% of county–years having minimum wages at least 10% higher than one of their bordering counties. These enormous time-series and cross-sectional variations provide an ideal setting to examine the effect of minimum wage policies on firms' activities (Gan, Hernandez, and Ma, 2016; Fan, Lin, and Tang, 2018; Hau, Huang, and Wang, 2020). The county-year minimum wage panel and ESR–CIC firm-year panel are linked by the county code. For most of the analyses, we use the end-of-year minimum wage as the minimum wage for the firm.[9]

[Insert Figure 1 about here]

2.3 County Border Map Data

The county border map is obtained from the Resource and Environment Science and Data Center of the Chinese Academy of Sciences. This map covers 2,866 counties across the 31 provinces, autonomous regions, and municipalities in Mainland China. When the borders of

[9] In our robustness checks, we also use the average minimum wage throughout the year and find similar results. See Table A1 in the internet appendix.

two counties touch, we treat them as neighboring county pairs. We identify 16,300 neighboring county pairs, with the average county having 5.7 neighboring counties. Altogether, 1,970 counties' neighboring counties are in the same province by themselves. In other words, 68.74% (1,970/2,866) of all counties do not have neighboring counties in other provinces.

Next, we merge the ESR–CIC matched firm-year panel with the neighboring county pair data based on geographic information. We obtain a firm's geographic coordinates (longitude and latitude) based on its address using the application program interface (API) from AutoNavi (Gao De Di Tu), a leading digital map and navigation provider in China. After merging the firm-year panel and county pair data, each firm may appear in the merged sample several times if the firm's county has several neighboring counties. After matching, we obtain a sample of 4,014,614 observations at the firm-year-neighboring county pair level. We then calculate the firm's distance to the border shared by neighboring county pairs. The average distance between ESR–CIC matched firms and county pair borders in the firm-year-county pair sample is 20.34 km with a standard deviation of 19.79. For the firms in county A, we use the firms in county A's neighboring counties as controls to estimate the minimum wage effects. Firms close to the border but on both sides of it (i.e., geographically proximate firms) are likely to have similar local economic conditions despite being subject to different minimum wage policies. These neighboring firms from neighboring counties serve as controls. Therefore, we restrict our sample to those firms located within 10 km of the neighboring county pair's border.[10]

2.4 Summary Statistics

Table I presents the summary statistics of the variables used in our analysis. The sample is at the firm-year-neighboring county pair level and restricted to those firms that located within

[10] Fewer than one-thirds of the firms in the ESR–CIC matched sample are located within 10 km of the border shared by neighbouring counties. In a robustness check, we also examine those firms located within 5 km and 15 km of the border shared by the county pairs and find similar results.

10 km of the shared border of neighboring counties. In total, 935,594 firm-year-country pair observations across 5,887 county pairs are included in our baseline analysis. There are substantial variations in minimum wages and firms' pollutant emissions. *LnMinWage* has a mean of 6.279 with a standard deviation of 0.492. *LnCODEmission* has a mean of 7.312 with a standard deviation of 3.535. SOEs comprise nearly one-fifth (19.2%) of the observations. Average firm size (i.e., *LnAsset*) is 11.200, slightly larger than the average firm size in other papers using the CIC database (e.g., Ru, 2018; Huang, Pagano, and Panizza, 2020). This is consistent with the sampling criteria of the ESR database, which typically covers firms with high production levels.

[Insert Table I about here]

III. Empirical Strategy and Findings

3.1 Empirical Design

Following the boundary discontinuity framework first proposed by Holmes (1998) and Black (1999), we examine the effects of minimum wages on firms' environmental policies by comparing the environmental policies of firms close to the border but on both sides of it. The premise of the framework is that firms close to the border have similar characteristics and face similar economic conditions despite being subject to different minimum wages (the regressor of interest). For the firms in each county, we use the firms in neighboring counties as controls. We construct a county pair sample for each border shared by two counties. We restrict the sample to firms within 10 km of the shared border to ensure that firms from different regions are comparable. The regression samples are at the firm-year-neighboring county pair level. The empirical specification is as follows:

$$LnCODEmission_{i,p,t} = \alpha + \beta \times LnMinWage_{i,t-1} + \gamma \times Controls_{i,p,t} + Firm\ FE +$$

$$County\ Pair\ FE + Industry \times Year\ FE + Province \times Year\ FE + \varepsilon_{i,p,t} \quad (1)$$

where the subscripts i, p, and t denote a firm, county pair, and year, respectively, and $LnCODEmission_{i,p,t}$ is the natural logarithm of one plus firm i's COD emissions in kilograms. $Controls_{i,p,t}$ denotes a vector of the firm and macro-economic variables. We include firm size, profitability, leverage, and total industrial output to control for the firm's time-variant characteristics. To account for the effects of local economic conditions, we include the log of GDP per capita and GDP growth at the city level. The macroeconomic variables are obtained from the China City Statistical Yearbooks.

Our specification further includes a series of fixed effects. We include province-year fixed effects to account for regional trends since minimum wage policies are determined at the province level. We include industry-year fixed effects to control for industry trends (e.g., technological advancement for removing pollutants). The inclusion of firm fixed effects mitigate the concerns that our results may be driven by certain firms. The county pair fixed effects are responsible for the time-invariant heterogeneities around the shared border of two neighboring counties. Since the presence of a single firm in multiple county pairs induces a mechanical correlation across county pairs, we cluster the standard errors at the county pair level.

3.2 Labor Cost Results

Our research builds on the assumption that minimum wage hikes significantly increase firms' labor costs, and firms adjust their environmental policies in response. Therefore, we first examine the effects of minimum wage policies on employees' wages. Prior studies find that Chinese firms largely comply with minimum wage policies, with fewer than 3.5% of full-time workers earning less than the legal monthly minimum wages (Ye, Gindling, and Li, 2015; Gan, Hernandez, and Ma, 2016). In addition, anecdotal evidence suggests that changes in the minimum wage indeed affect the labor costs of manufacturing firms. For example, *The China*

Times report that minimum wage increases in 14 provinces in 2010 raised firms' labor costs in the textile and garment industry and squeezed their profits. *The Economic Observer* surveyed manufacturing firms in the Pearl River Delta economic zone and finds that manufacturing firms face intense labor cost pressure from the dramatic increase in minimum wages.[11]

Our empirical analysis of the extent to which minimum wages affect firms' labor costs follows our baseline analysis in specification (1). Table II presents the regression results. In columns (1) and (2), (3) and (4), and (5) and (6), we restrict the sample to firms located within 5 km, 10 km, and 15 km of the shared border of neighboring counties, respectively. The dependent variable *Ln(Wage/Worker)* is the natural logarithm of the yearly wage expenditure of the manufacturing firm over the total number of employees. The coefficients on *LnMinWage* in all the columns are significantly positive. For example, in column (1), the coefficient on *LnMinWage* is 0.100 at the 1% significance level, which means that a 10% increase in minimum wages leads to a 1% (= 10%*0.100) increase in firms' average wages. These results suggest that firms' labor costs rise with an increase in the minimum wage, consistent with the findings Gan, Hernandez, and Ma (2016) and Hau, Huang, and Wang (2020).

[Insert Table II about here]

3.3 Baseline Results and Robustness

Table III reports the results from the baseline regressions. In column (1), the coefficient on *LnMinWage* is positive and significant at the 5% level, suggesting that firms facing higher minimum wages increase their COD emissions. These results are not driven by industry or provincial trends such as province-level environmental regulations, since industry-year and province-year fixed effects are controlled for in the regressions. The coefficients barely change when we further control for firm-level characteristics such as firm size, leverage, profitability,

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[11] See the detailed discussions of the effects of minimum wages on manufacturing firms in the textile and garment industry in https://www.chinatimes.net.cn/article/14289.html and in the Pearl River Delta economic zone in http://news.sohu.com/20100414/n271513014.shtml.

and industrial output as well as for macro-economic conditions such as GDP per capita and GDP growth. Consistent with the literature on industrial firms' pollutant emissions (Xu and Kim, 2021), we find that larger firms (*Size*) with higher production levels (*LnIndOutput*) emit higher volumes of chemical pollutants. Moreover, firms' COD emission is negatively correlated with GDP per capita, suggesting that firms' emissions fall as economic development proceeds. In columns (4) and (6), when we restrict the sample to firms located within 10 km or 15 km of the shared border of neighboring counties, we continue to find the coefficients on *LnMinWage* are positive at the 1% significance level. In terms of economic significance, the coefficient on *LnMinWage* is 0.463, indicating that a 10% increase in minimum wages corresponds to a 4.63% (10%*0.463) increase in COD emissions.

[Insert Table III about here]

Our findings from the baseline analysis reveal that industrial firms indeed change their environmental policies by emitting more pollutants when they face higher minimum wages. Complementing the literature on manufacturing firms' response to minimum wages in China (Gan, Hernandez, and Ma, 2016; Hau, Huang, and Wang, 2020), our results show that firms change their environmental policies to offset the rising labor costs induced by minimum wage policies. In other words, the cost of minimum wages may be partly paid by the environment. Our baseline results also highlight the effects of non-climate policies on firm's environmental performance (Bartram, Hou, and Kim, 2021).

To validate the sensitivity of our baseline results, we conduct a battery of robustness tests. As shown in the baseline regressions, a firm's industrial output is positively correlated with its COD emissions. If a firm's output simultaneously rises with the increase in the minimum wage, the increased COD emissions are not necessarily caused by the minimum wage hikes; they could also be caused by the increase in total industrial output. Alternatively, firms may undertake fewer pollutant removal activities and pollute more. To test this, we calculate the proportion of pollutants removed (i.e., COD removed) out of the COD eventually released and explore the effects of local minimum wages on firms' COD removal. As shown in Panel A of Table IV, the coefficients on *LnMinWage* are negatively significant in all three columns, suggesting that firms' pollutant removal decreases with an increase in minimum wages.

Next, we corroborate our baseline findings by exploring other pollutants, including the emissions of NH_3-N, SO_2, NO_x, and industrial gas discharge (*GasDischarge*). A high NH_3-N level in water makes it difficult for aquatic organisms to sufficiently excrete the toxicant, leading to an internal toxicant buildup in them, and potentially, their death. SO_2 is the primary cause of acid rain. As in our baseline analysis, we take the natural logarithm of the pollutant emission levels and use this as the dependent variable in our regressions. For brevity, we report the results based on the sample of firms located within 10 km of the shared border of the neighboring counties. As shown in Panel B of Table IV, the coefficients of *LnMinWage* are significantly positive (columns (1) and (2)), suggesting that firms increase their NH_3-N and SO_2 emissions when they face higher minimum wages. In column (4), we also find that higher minimum wages lead to higher industrial gas discharges. Overall, our baseline results are robust to including the other pollutants covered by the ESR database.

[Insert Table IV about here]

Firms may adjust their environmental policies in response to the average minimum wage in the previous year. Therefore, we further test the relation between the average minimum wage in the previous year and firms' COD emissions. The independent variable of interest *LnMinAvgWage* is the weighted yearly minimum wage in the previous year divided by 12. As shown in all the columns of Table A1 in the internet appendix, the coefficients on *LnMinAvgWage* are significantly positive. This lends further support to the findings in our baseline analysis.

3.4 Moderating Effect of Ownership Type

In this sub-section, we explore the moderating effect of ownership type on the relationship between minimum wages and a firm's environmental performance. State-owned enterprises (SOEs) are important components of the Chinese economy, with 180,976 SOEs present in our sample from 1998 to 2013. These SOEs contributed to over one-quarter of total industry output for all above-scale manufacturing firms. However, previous studies provide mixed views on the role of SOEs (Stiglitz, 1993; Shleifer, 1998). On the one hand, SOEs have always been criticized for their poor corporate governance as well as lower efficiency and productivity (La Porta and Lopez-de-Silanes, 1999; Firth, Fung, and Rui, 2006; Fan, Wong, and Zhang, 2007). Selling the state-owned shares to the private sector (i.e., privatization) may improve SOEs' efficiency (Megginson and Netter, 2001; Liao, Liu, and Wang, 2014; Ru and Zou, 2022). On the other hand, SOEs may be valuable for tasks other than financial performance (Bai et al., 2000; Xu, 2011; Lin et al., 2020). For example, Bai, Lu, and Tao (2006) find that SOEs are capable of hiring excess labor during economic downturns to maintain social stability. More recently, Hsu, Liang, and Matos (2021) show that SOEs are more responsive to sustainability issues. Since SOEs are typically backed by state resources, subsidies, and soft-budget constraints, they may put more efforts into addressing externalities than private enterprises (Carney and Child 2013, Boubakri et al. 2017, Musacchio and Lazzarini 2014, Musacchio, Lazzarini, and Aguilera, 2015). In the following analyses, we therefore explore the role of state ownership in addressing environmental externalities when facing competitive shocks from minimum wages.

To test the moderating effects of state ownership, we split the sample into SOEs and non-SOEs and estimate the effects of minimum wages on pollutant emissions in each sample. To test the statistical significance, we conduct a full sample regression with *LnMinWage* interacted with the SOE indicator. Results are reported in Table V. In Panel A of Table V, we first focus on the two most important pollutants: COD and SO_2. In columns (1) and (2), the coefficient on

LnMinWage is 0.601 at the 1% significance level in the non-SOE sample, while it is statistically insignificant for SOEs. This finding suggests that the impact of minimum wages on COD emissions is less evident for SOEs. In column (3), the coefficient on the interaction between *LnMinWage* and *SOE* is -0.452 at the 1% significance level, suggesting that the effects of minimum wages on COD emissions are indeed significantly lower for SOEs. In terms of economic significance, the effect of *LnMinWage* on COD emissions is 82.2% lower for SOEs. In columns (4)–(6), we examine the moderating effects of state ownership on the relationship between minimum wages and SO_2 emissions. Consistent with our expectations, the coefficient on *LnMinWage* is 0.468 at the 1% significance level for the non-SOEs, while it is statistically insignificant for SOEs. Moreover, the coefficient on the interaction between *LnMinWage* and *SOE* is -0.586 at the 1% significance level, confirming the different responses of SOEs and non-SOEs when they face minimum wage hikes.

In Panel B of Table V, we include additional industrial pollutants variables such as NH_3-N emissions, NO_x emissions, and industrial gas discharges. The coefficients on *LnMinWage* in columns (1), (4), and (7) are positively significant for non-SOEs, while they are insignificant for SOEs in the corresponding columns. The coefficients on the interaction between *LnMinWage* and *SOE* are negative at the 1% significance level in columns (3), (6), and (9), suggesting that, relative to SOE firms, non-SOE firms emit more NH_3, NO_x, and pollutants when experiencing local minimum wage increases.

[Insert Table V about here]

Overall, the results in Table V reveal the moderating effects of state ownership on the relationship between minimum wages and industrial pollution. Our findings suggest that, SOEs are better than non-SOEs at absorbing environmental externalities when facing competitive shocks from minimum wages. These results complement the prior literature on the value of SOEs in non-profitability-related tasks (Stiglitz, 1993; Bai, Lu, Tao, 2006; Hsu, Liang, and

Matos, 2021).

3.5 Underlying Mechanisms

Firms generally undertake “end-of-pipe” adjustments to remove pollutants and thus reduce emissions. When the local minimum wage increases, they may reduce “end-of-pipe” interventions such as investment in the wastewater treatment system in response to their increased labor costs. Following He, Wang, and Zhang (2020), we thus measure firms' abatement efforts using the number of wastewater treatment facilities and wastewater treatment capacity in tons per day. We scale the absolute number by firms' industrial output to measure whether their “end-of-pipe” intervention investments meets production requirements. Results are reported in Table VI. In columns (1) and (2), we estimate the effects of minimum wages on firms' water treatment facilities for the non-SOEs and SOEs separately. In column (1), the coefficient on *LnMinWage* is -0.069 at the 5% significance level. This suggests that the non-SOEs reduce their investment in wastewater treatment facilities in response to minimum wage hikes. In column (2), the coefficient on *LnMinWage* is statistically insignificant. In column (3), the coefficient on *LnMinWage* is significantly negative, and the coefficient on the interaction between *LnMinWage* and *SOE* is 0.021 at the 5% significance level. In columns (4)–(6), we examine whether the effects of minimum wages on firms' wastewater treatment capacity depend on their ownership type. We find that the coefficient on *LnMinWage* is significantly negative in column (4) but insignificant in column (5). Moreover, the coefficient on the interaction between *LnMinWage* and *SOE* is 0.057 at the 5% significance level.

[Insert Table VI about here]

The findings in Table VI suggest that the impact of minimum wages on firms' abatement efforts depends on firms' ownership type. Although firms may not sell their wastewater treatment facilities in response to minimum wage increases, those facing competitive shocks from minimum wage raises may not invest in pollution abatement as much as other firms do.

Moreover, when facing minimum wage hikes, non-SOEs are more likely to cut their investment in pollution abatement. Taken together, the results in Table VI explain the environmental performance gap between SOEs and non-SOEs documented in Table V.

3.6 Heterogeneity Analysis

In the previous analyses, we find that firms reduce their pollution abatement efforts and emit higher volume of pollutants in response to minimum wage hikes. However, firms' response to environmental policies depends on their product market power, sensitivity to minimum wages, financial conditions, and environmental regulations. We now explore these cross-sectional dimensions.

3.6.a Product Market Power

Firms with stronger product market power may have greater bargaining power with their downstream customers and thus be more likely to transfer labor costs downstream. For example, Harasztosi and Lindner (2019) find that around 75% of the minimum wage increase in Hungary is paid by consumers through higher prices. We thus expect firms with greater product market power to pass fewer labor costs onto the environment by increasing pollutant emissions, as they instead pass them onto consumers.

Following the literature (e.g., Lindenberg and Ross, 1981; Datta, Iskandar-Datta, and Sigh, 2013), we measure firms' product market power by the Lerner Index, which equals the price–cost margin over total sales. A higher Lerner Index means a higher price–cost margin and thus greater product market power. We calculate the firm-year level Lerner Index and then aggregate it at the two-digit industry-year level. Each year, industries are sorted based on their industry-wide Lerner Index. Industries above the median industry-wide Lerner Index are defined as those with high product market power. We examine the effects of minimum wages on firms' environmental performance in two sub-samples: high Lerner Index industry firms and low Lerner Index industry firms.

Results are presented in Panel A of Table VII. In column (1), the coefficient on *LnMinWage* is 0.639 at the 1% significance level for firms with low product market power. By contrast, the coefficient on *LnMinWage* is much lower and statistically insignificant for firms with high product market power. In column (3), the coefficient on the interaction between *LnMinWage* and *PMC* is -0.287 at the 1% significance level, suggesting that firms with low product market power are more likely to pass labor costs onto the environment by increasing pollutant emissions in response to minimum wage hikes.

[Insert Table VII about here]

3.6.b Minimum Wage Sensitivity

Firms' response to minimum wages depends on their sensitivity to the minimum wage policies. Firms hiring more minimum wage workers tend to be more sensitive to minimum wage policies. However, as no payroll information on employees is available, we use two measures to proxy for firms' sensitivity to minimum wages: labor intensity and average wage. In this sub-section, we explore the effects of minimum wages along these two dimensions.

A firm's labor intensity equals the annual wage expenditure over total assets. A higher ratio means higher labor intensity. We calculate two-digit industry-year level labor intensity by considering the average labor intensity across all the firms in each industry in each year. Each year, industries are sorted based on their industry-wide labor intensity. Industries above the median industry's labor intensity are defined as high labor intensity industries (i.e., they are highly sensitive to minimum wages).

A firm's average wage equals yearly wage expenditure over the total number of employees. Firms with higher average wages are less likely to hire workers earning minimum wages and are thus less sensitive to the minimum wage hikes. We calculate the firm-year-level average wage and aggregate it at the two-digit industry-year level. Industries are sorted based on their industry-wide average wage each year. Industries above the median industry's average wage are defined as high average wages industries (i.e., they have low sensitivity to minimum wages).

Results are reported in Panel B and Panel C of Table VII. In column (1) of Panel B, the coefficient on *LnMinWage* is 0.041 and statistically insignificant, while in column (2), the coefficient on *LnMinWage* is 0.821 at the 1% significance level. In column (3), the coefficient on the interaction between *LnMinWage* and *Labor Intensity* is 0.151 at the 5% significance level. These results suggest that firms with higher labor intensity are more sensitive to the minimum wages and thus emit more pollutants when facing minimum wage hikes.

In Panel C, the coefficient on *LnMinWage* is smaller in the high-wage sample than that in the low-wage sample. In column (3), the coefficient on the interaction between *LnMinWage* and *AverageWage* is -0.141 at the 1% significance level. These results suggest that firms with higher average wage are less responsive to minimum wage hikes.

3.6.c Financial Constraints

Our next set of cross-sectional tests explores firms' heterogeneity in financial constraints. Firms with higher financing costs (i.e., financially constrained firms) are incentivized to reduce abatement activities and increase pollutant emissions (Xu and Kim, 2021). Following Hadlock and Pierce (2010) and Manova, Wei, and Zhang (2015), we use firm size to proxy for the financial constraint level.[12] We divide our baseline sample into financially constrained and unconstrained firms.

Results are reported in Panel D of Table VII. In column (1), the coefficient on *LnMinWage* is 0.283 for non-financially constrained firms, significant at the 10% level, whereas the coefficient on *LnMinWage* is 0.569 for financially constrained firms, significant at the 1% level. In column (3), the coefficient on the interaction between *LnMinWage* and *Small Firm* is positive at the 1% significance level, suggesting that financially constrained firms are more likely to

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[12] Hadlock and Pierce (2010) find that firm size and age are the most useful predictors of listed U.S. firms' financial constraint. Manova, Wei, and Zhang (2015) use firm size to proxy for financial constraints and test its effects on the export performance of Chinese manufacturing firms.

reduce their environmental expenditures in response to minimum wage hikes.

3.6.d Pollution Discharge Fees

Although firms may pass their labor costs onto the environment by increasing pollutant emissions, their environmental policies might depend on environmental regulation and/or pollution discharge fees. This sub-section explores the moderating effects of pollution discharge fees on the relationship between minimum wages and industrial pollution.

In July 2003, a comprehensive pollution charge policy came into effect in China. COD emissions were charged at 0.7 RMB/kg, while the SO_2 emission fee increased to 0.63 RMB/kg in July 2005 from 0.21 RMB/kg in July 2003.[13] In 2007, the State Council set a Comprehensive Work Plan for Energy Conservation and Emission Reduction. This plan aimed to reduce energy consumption per unit of GDP by 20% and the total discharge of major pollutants by 10% during the 11th Five-Year Plan period. In particular, the plan stated that the SO_2 emission fee should increase to 1.26 RMB/kg within three years and that local governments should increase the COD emission fee according to local conditions.

The variations in COD and SO_2 charges across provinces are shown in Panels A and B of Table VIII, respectively. These variations in pollution charges provide a valuable setting to test whether the impact of minimum wage hikes on firms' environmental policies depends on discharge fees. As shown in Panel C of Table VIII, the coefficients on the interactions between *LnMinWage* and *COD Charges* and between *LnMinWage* and *SO_2 Charges* are -0.597 and -0.605, respectively, both at the 1% significance level. These results suggest that firms are keenly aware of the external regulatory environment when trading off labor costs and pollution controls. With the increase in labor costs owing to minimum wage hikes, firms located in provinces with lower pollution charges are more likely to pass their labor costs onto the

[13] Here, 1 kg of COD translates into one unit of water pollution equivalent and 0.95 kg of SO2 translates into one unit of gas pollution equivalent. Thus, one water (gas) pollution equivalent unit is charged at RMB 0.7 (0.6).

environment by increasing pollutant emissions.

[Insert Table VIII about here]

3.7 Aggregate Effects of Minimum Wages

The previous results on the effects of minimum wages are found at the intensive margin. However, polluting firms may exit due to minimum wage hikes. Hence, we must explore the aggregate impact of minimum wages on regional pollution levels as well as the aggregate economic consequences (e.g., financial performance), especially for regions with high SOE ratio. Drawing on the previous results, we hypothesize that counties with a high SOE ratio are less likely to pass their labor cost onto the environment by increasing pollutant emissions. We also conjecture that the emission constraints of SOEs may not be conducive to their economic benefits. We follow the framework in the baseline analysis and compare the pollution of neighboring counties. Specifically, we construct a county pair-year sample to examine the effects of minimum wages on COD emissions and financial performance.

As shown in column (1) of Table IX, the coefficient on *LnMinWage* is 0.622 at the 1% significance level, suggesting that firms in counties with higher minimum wages pollute more intensively. Moreover, the coefficient on the interaction between *LnMinWage* and *SOERatio* is -0.535 at the 1% significance level, suggesting the role of SOEs in absorbing externalities. The results are similar when including regional industrial output and other controls in column (2). In columns (3) and (4), we examine the effects of minimum wages on financial performance. In column (3), the coefficient on *LnMinWage* is -2.557 at the 1% significance level, suggesting that shareholders bear a proportion of the labor cost increase due to minimum wage hikes. The coefficient on the interaction between *LnMinWage* and *SOERatio* is -1.466 at the 1% significance level, suggesting that these SOEs absorb the externalities themselves and perform worse financially.

[Insert Table IX about here]

IV. Conclusion

We use establishment-level data to study how the minimum wage hikes influence firms' environmental performance. We hypothesize that an increase in the minimum wage incentivizes firms to reallocate expenditures between employment and environmental abatement, resulting in unintended effects on the environment. Treating the pollutant emissions generated during manufacturing is costly and consumes significant financial resources. Firms reduce abatement expenditure when facing increased labor costs. Indeed, in China, given that firms' costs of abating emissions are much smaller than pollution charges, they choose to emit the additional pollutants instead of internalizing the pollution treatment costs, thereby imposing additional costs on the environment, society, and public health. Moreover, we find that the negative externalities of minimum wage policies are less pronounced for SOEs, which are created to deal with market failures and contribute significantly to the Chinese economy. The cross-sectional results also show that the documented impacts of the minimum wages are amplified by financial constraints, low product market power, labor intensity, and weak environmental regulations. These results consistently point to the environmental externalities of minimum wage policies.

Our study provides several policy implications. The literature has largely investigated different payers of minimum wages (i.e., consumers, firm owners, and employees) and firms' responses to minimum wage policies; however, we document the unintended consequences of the minimum wage on corporate environmental policies, thus adding to the debate on the minimum wage policy. We also contribute to the literature on the relation between labor market friction and corporate policies. Finally, our results highlight the benefits of state ownership when dealing with externalities. Collectively, our results caution policymakers about the unintended environmental consequences of implementing minimum wage policies.

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Appendix Table for Variable Definitions

Variable	Definition
LnMinWage	The natural logarithm of the end-of-year monthly minimum wage in each county in the previous year.
LnCODEmission	The natural logarithm of one plus firm's chemical oxygen demand (COD) emission in kilograms.
LnSO$_2$Emission	The natural logarithm of one plus firm's sulfur dioxide (SO_2) emission in kilograms.
LnNH3-NEmission	The natural logarithm of one plus firm's ammonia nitrogen (NH_3-N) emission in kilograms.
LnNO$_x$Emission	The natural logarithm of one plus firm's nitrogen oxide (NO_x) emission in kilograms.
LnGasDischarge	The natural logarithm of one plus firm's industrial waste gas discharged in 10,000 cubic meters.
CODRemoved	The kilograms of COD removed scaled by kilograms of COD emitted.
Ln(Wage/Worker)	The natural logarithm of yearly total wage expenditure over total number of employees.
WaterCapacity	The wastewater treatment capacity in tons per day over industrial output.
WaterFacility	The number of wastewater treatment facilities over industrial output times 1000.
SOE	An indicator that equals one if firm is registered as state-owned enterprises (110), collectively owned enterprise (120), state-owned joint venture (141), collectively owned joint venture (142), state and collectively owned joint venture (143), or wholly state-owned company (151) and zero otherwise.
LnAsset	The natural logarithm of total asset.
Profitability	The firm's operating profit over total asset.
Leverage	The total liability over total asset.
LnIndOutput	The natural logarithm of one plus firm's industrial output in 10,000 RMB.
GDP Per Capita	The GDP over total population in the city where the firm is located.
GDP Growth	The GDP growth in the city where the firm is located.
PMC	An indicator that equals one if the firm is in the high product marker power industry in this year. The industry wide product market power is the average Lerner Index of all firms in this industry. The Lerner Index is computed by dividing the difference between operating income and operating expense by operating income.

LaborIntensity	An indicator that equals one if the firm is in the high labor intensity industry in this year. The industry wide labor intensity is measured by the average labor intensity of all firms in this industry. The labor intensity equals firm's yearly total wage expenditure over total assets.
AverageWage	An indicator that equals one if the firm is in the high average wage industry in this year. The industry wide average wage is measured by the average wage of all firms in this industry. The average wage equals firm's yearly total wage expenditure over number of employees.
Small Firm	An indicator that equals one if firm size above the sample median and zero otherwise.
CODCharges	The per kilograms pollution fees for chemical oxygen demand (COD) emissions at the end of the year.
SO_2Charges	The per kilograms pollution fees for sulfur dioxide (SO_2) emissions at the end of the year.
SOERatio	The percentage of firms that are registered as SOE in each county.
LnAvgIndOutput	The natural logarithm of total industry output across all industrial firms in each county.

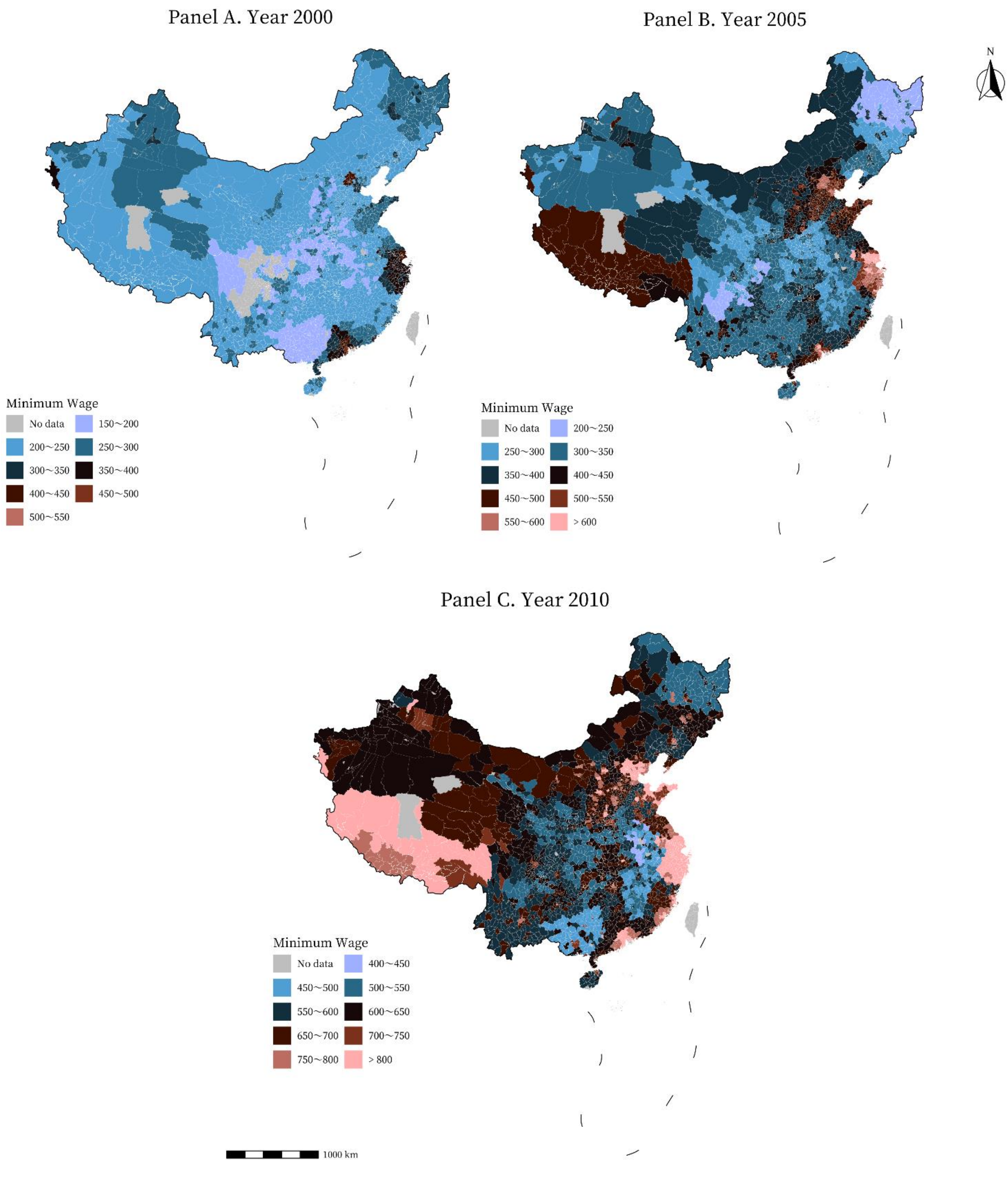

Figure 1. Geographical Distribution of Minimum Wages in China

This figure displays the minimum wages across counties in China. Panel A, B, and C plots the minimum wages in 2000, 2005, and 2010, respectively. Minimum wages at different levels are marked by different colors, with light blue (pink) denoting the lowest (highest) minimum wages.

Table I Summary Statistics

This table presents summary statistics of the firm × year × neighboring county pair level data. Sample is restricted to firms located within 10 kilometers from the border of neighboring counties. The firm × year × county pair data of the baseline regression sample consists of 935,594 observations with 103,246 unique firms and 5,887 county pairs from 1998 to 2013. *LnMinWage* is the natural logarithm of the end-of-year monthly minimum wage in each county in the previous year. *LnCODEmission* is the natural logarithm of one plus firm's chemical oxygen demand (COD) emission in kilograms. *$LnSO_2Emission$* is the natural logarithm of one plus firm's sulfur dioxide (SO_2) emission in kilograms. *$LnNH_3$-NEmission* is the natural logarithm of one plus firm's ammonia nitrogen (NH_3-N) emission in kilograms. *$LnNO_xEmission$* is the natural logarithm of one plus firm's nitrogen oxide (NO_x) emission in kilograms. *LnGasDischarge* is the natural logarithm of one plus firm's industrial waste gas discharged in 10,000 cubic meters. *CODRemoved* is kilograms of COD removed scaled by kilograms of COD emitted. *Ln(Wage/Worker)* is the natural logarithm of yearly total wage expenditure over total number of employees. *WaterCapacity* is the wastewater treatment capacity in tons per day over industrial output. *WaterFacility* is the number of wastewater treatment facilities over industrial output times 1000. *SOE* is an indicator that equals one if firm is registered as state-owned enterprises (110), collectively owned enterprise (120), state-owned joint venture (141), collectively owned joint venture (142), state and collectively owned joint venture (143), or wholly state-owned company (151) and zero otherwise. *LnAsset* is the natural logarithm of total asset. *Profitability* is the firm's operating profit over total asset. *Leverage* is the total liability over total asset. *LnIndOutput* is the natural logarithm of one plus firm's industrial output. *GDP Per Capita* and *GDP Growth* are the GDP over total population and GDP growth in the city where the firm is located, respectively.

Variables	N	Mean	S.D.	P25	P50	P75
LnMinWage	935,594	6.279	0.492	5.914	6.292	6.659
LnCODEmission	935,594	7.312	3.535	5.861	7.938	9.677
LnSO2Emission	935,590	6.767	4.876	0.000	8.590	10.499
$LnNH_3$-NEmission	845,473	3.155	3.413	0.000	2.370	6.066
$LnNO_xEmission$	567,414	5.439	4.688	0.000	6.948	9.261
LnGasDischarge	771,652	5.983	3.896	3.161	6.868	8.659
CODRemoved	821,007	4.496	9.456	0.000	0.468	4.183
Ln(Wage/Worker)	848,588	9.616	0.822	9.085	9.569	10.113
WaterCapacity	748,031	0.267	0.793	0.000	0.019	0.136
WaterFacility	747,381	0.607	2.516	0.011	0.118	0.459
SOE	935,591	0.192	0.394	0.000	0.000	0.000
LnAsset	935,594	11.200	1.650	10.014	11.081	12.256
Profitability	935,594	7.179	17.304	-0.112	2.430	9.201
Leverage	935,594	0.600	0.289	0.402	0.602	0.787
LnIndOutput	935,594	8.362	2.051	7.266	8.367	9.564
GDP Per Capita	935,594	40.326	36.735	14.667	28.443	52.314
GDP Growth	935,594	0.146	0.063	0.105	0.143	0.185

Table II Minimum Wages and Firm's Labor Cost

This table presents the OLS regression results of minimum wages on firm's labor cost. Regression samples are at the firm × year × neighboring county pair level. The dependent variable *Ln(Wage/Worker)* is the natural logarithm of yearly total wage expenditure over total number of employees. The independent variable of interest *LnMinWage* is the natural logarithm of the end-of-year monthly minimum wage in each county in the previous year. In columns (1) and (2), (3) and (4), and (5) and (6), samples are restricted to firms located within 5, 10, 15 kilometers from the border of neighboring counties, respectively. In columns (2), (4), and (6), firm and macro-economic controls are included in the regression. The firm-level controls include the firm's total assets, leverage, profitability, and industrial output. Macro-economic controls include the GDP per capita and GDP growth of the city where the firm is located. All specifications include firm, neighboring county pair, industry × year, and province × year fixed effects. Standard errors are clustered at the neighboring county pair level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

	5 KM		10 KM		15 KM	
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	*Ln(Wage/Worker)*	*Ln(Wage/Worker)*	*Ln(Wage/Worker)*	*Ln(Wage/Worker)*	*Ln(Wage/Worker)*	*Ln(Wage/Worker)*
LnMinWage	0.100***	0.091***	0.075***	0.059***	0.084***	0.067***
	(3.20)	(3.07)	(3.25)	(2.71)	(4.47)	(3.75)
LnAsset		0.124***		0.129***		0.134***
		(34.77)		(50.46)		(62.78)
Profitability		0.004***		0.004***		0.004***
		(26.21)		(37.88)		(45.16)
Leverage		0.012		0.001		-0.005
		(1.47)		(0.24)		(-1.03)
LnIndOutput		0.010***		0.011***		0.011***
		(10.97)		(15.88)		(18.95)
GDP Per Capita		0.001***		0.001***		0.001***
		(3.48)		(3.82)		(4.04)
GDP Growth		0.145***		0.133***		0.138***
		(4.26)		(5.26)		(6.46)
Firm FE	YES	YES	YES	YES	YES	YES
County Pair FE	YES	YES	YES	YES	YES	YES
Industry × Year FE	YES	YES	YES	YES	YES	YES
Province × Year FE	YES	YES	YES	YES	YES	YES
Observations	421,594	419,472	852,024	846,711	1,254,999	1,245,536
Adj. R-squared	0.743	0.751	0.751	0.758	0.757	0.764

Table III Minimum Wages and Pollution Emission

This table presents the OLS regression results of minimum wages on firm's chemical oxygen demand (COD) emissions. Regression samples are at the firm × year × neighboring county pair level. The dependent variable *LnCODEmission* is the natural logarithm of one plus firm's COD emission in kilograms. The independent variable of interest *LnMinWage* is the natural logarithm of the end-of-year monthly minimum wage in each county in the previous year. In columns (1) and (2), (3) and (4), and (5) and (6), samples are restricted to firms located within 5, 10, 15 kilometers from the border of neighboring counties, respectively. In columns (2), (4), and (6), firm and macro-economic controls are included in the regression. The firm-level controls include the firm's total assets, leverage, profitability, and industrial output. Macro-economic controls include the GDP per capita and GDP growth of the city where the firm is located. All specifications include firm, neighboring county pair, industry × year, and province × year fixed effects. Standard errors are clustered at the neighboring county pair level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

	5 KM		10 KM		15 KM	
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	*LnCODEmission*	*LnCODEmission*	*LnCODEmission*	*LnCODEmission*	*LnCODEmission*	*LnCODEmission*
LnMinWage	0.415**	0.340*	0.495***	0.463***	0.566***	0.530***
	(2.05)	(1.69)	(3.49)	(3.24)	(4.73)	(4.39)
LnAsset		0.197***		0.191***		0.185***
		(14.33)		(19.82)		(23.43)
Profitability		0.003***		0.003***		0.003***
		(5.47)		(7.85)		(9.23)
Leverage		0.017		0.026		0.025
		(0.50)		(1.09)		(1.32)
LnIndOutput		0.227***		0.241***		0.253***
		(29.01)		(40.01)		(48.63)
GDP Per Capita		-0.007***		-0.006***		-0.006***
		(-3.54)		(-3.49)		(-3.77)
GDP Growth		0.497**		0.481***		0.486***
		(2.16)		(2.77)		(3.35)
Firm FE	YES	YES	YES	YES	YES	YES
County Pair FE	YES	YES	YES	YES	YES	YES
Industry × Year FE	YES	YES	YES	YES	YES	YES
Province × Year FE	YES	YES	YES	YES	YES	YES
Observations	495,119	462,766	1,004,795	935,594	1,483,431	1,377,089
Adj. R-squared	0.653	0.664	0.665	0.676	0.675	0.687

Table IV Robustness Checks

This table presents the OLS regression results of minimum wages on firm's pollution removal and other pollutants' emissions. Regression samples are at the firm × year × neighboring county pair level. The independent variable of interest *LnMinWage* is the natural logarithm of the end-of-year monthly minimum wage in each county in the previous year. Panel A presents the results for COD pollution removal. In Panel A, the dependent variable *CODRemoved* is kilograms of COD removed scaled by kilograms of COD emitted. In columns (1), (2) and (3), samples are restricted to firms located within 5, 10, 15 kilometers from the border of neighboring counties, respectively. Panel B presents the results for alternative pollution measures. Samples in all columns are restricted to firms located within 10 kilometers from the border of neighboring counties. *LnSO2Emission* is the natural logarithm of one plus firm's sulfur dioxide (SO_2) emission in kilograms. *LnNH3-NEmission* is the natural logarithm of one plus firm's ammonia nitrogen (NH_3-N) emission in kilograms. *LnNOxEmission* is the natural logarithm of one plus firm's nitrogen oxide (NO_x) emission in kilograms. *LnGasDischarge* is the natural logarithm of one plus firm's industrial waste gas discharged in 10,000 cubic meters. All specifications include firm and macro-economic controls. The firm-level controls include the firm's total assets, leverage, profitability, and industrial output. Macro-economic controls include the GDP per capita and GDP growth of the city where the firm is located. All specifications include firm, neighboring county pair, industry × year, and province × year fixed effects. Standard errors are clustered at the neighboring county pair level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Panel A: Pollution Removal

	5 KM	10 KM	15 KM
	(1)	(2)	(3)
Variables	*CODRemoved*	*CODRemoved*	*CODRemoved*
LnMinWage	-1.751***	-1.249***	-0.935**
	(-3.27)	(-2.92)	(-2.15)
Controls	YES	YES	YES
Firm FE	YES	YES	YES
County Pair FE	YES	YES	YES
Industry × Year FE	YES	YES	YES
Province × Year FE	YES	YES	YES
Observations	405,510	818,533	1,203,896
Adj. R-squared	0.530	0.545	0.557

Panel B: Emissions for Other Pollutants

	(1)	(2)	(3)	(4)
Variables	*LnSO2Emission*	*LnNH3-NEmission*	*LnNOxEmission*	*LnGasDischarge*
LnMinWage	0.343***	0.305*	0.122	0.280***
	(2.95)	(1.77)	(0.53)	(2.68)
Controls	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
County Pair FE	YES	YES	YES	YES
Industry × Year FE	YES	YES	YES	YES
Province × Year FE	YES	YES	YES	YES
Observations	935,590	844,669	566,221	765,193
Adj. R-squared	0.840	0.692	0.810	0.830

Table V Minimum Wages, State Ownership, and Pollution Emission

This table presents the OLS regression results of minimum wages on firm's industrial emissions across different types of ownership. Regression samples are at the firm × year × neighboring county pair level and restricted to firms within 10 kilometers from the border of neighboring counties. *LnMinWage* is the natural logarithm of the end-of-year monthly minimum wage in each county in the previous year. *SOE* is an indicator that equals one if firm is registered as state-owned, and zero otherwise. Panel A focuses on the two major pollutants: COD and SO_2. *LnCODEmission* is the natural logarithm of one plus firm's COD emission in kilograms. *LnSO₂Emission* is the natural logarithm of one plus firm's sulfur dioxide (SO_2) emission in kilograms. Panel B focuses on emissions for other pollutants including NH_3-N, NO_x, and Gas Discharge. *LnNH₃-NEmission* is the natural logarithm of one plus firm's ammonia nitrogen (NH_3-N) emission in kilograms. *LnNOₓEmission* is the natural logarithm of one plus firm's nitrogen oxide (NO_x) emission in kilograms. *LnGasDischarge* is the natural logarithm of one plus firm's industrial waste gas discharged in 10,000 cubic meters. All specifications include firm and macro-economic controls. The firm-level controls include the firm's total assets, leverage, profitability, and industrial output. Macro-economic controls include the GDP per capita and GDP growth of the city where the firm is located. In the full sample regressions, the main effects of *SOE* are also controlled. All specifications include firm, neighboring county pair, industry × year, and province × year fixed effects. Standard errors are clustered at the neighboring county pair level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Panel A: COD and SO_2 Emissions

	(1)	(2)	(3)	(4)	(5)	(6)
	LnCODEmission			*LnSO₂Emission*		
Variables	Non-SOE	SOE	Full Sample	Non-SOE	SOE	Full Sample
LnMinWage	0.601***	-0.248	0.550***	0.468***	-0.313	0.454***
	(3.79)	(-0.96)	(3.84)	(3.53)	(-1.57)	(3.91)
LnMinWage × SOE			-0.452***			-0.586***
			(-10.87)			(-13.39)
Controls	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
County Pair FE	YES	YES	YES	YES	YES	YES
Industry × Year FE	YES	YES	YES	YES	YES	YES
Province × Year FE	YES	YES	YES	YES	YES	YES
Observations	754,787	178,802	935,591	754,783	178,802	935,587
Adj. R-squared	0.680	0.721	0.676	0.844	0.853	0.840

Table V Minimum Wages, State Ownership, and Pollution Emission - *continued*

Panel B: Emissions for Other Pollutants

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	LnNH₃-NEmission			*LnNOₓEmission*			*LnGasCharge*		
Variables	Non-SOE	SOE	Full Sample	Non-SOE	SOE	Full Sample	Non-SOE	SOE	Full Sample
LnMinWage	0.402**	-0.038	0.351**	0.173	-0.061	0.144	0.395***	-0.196	0.405***
	(2.09)	(-0.16)	(2.02)	(0.71)	(-0.12)	(0.62)	(3.19)	(-1.27)	(3.88)
LnMinWage × *SOE*			-0.316***			-0.369***			-0.566***
			(-6.55)			(-3.69)			(-15.30)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Pair FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry × Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Province × Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	716,693	126,309	844,666	520,546	44,740	566,218	592,527	170,667	765,193
Adj. R-squared	0.691	0.746	0.692	0.810	0.836	0.810	0.826	0.871	0.830

Table VI Minimum Wages, State Ownership, and Abatement Efforts

This table presents the OLS regression results of minimum wages on firm's abatement efforts across different types of ownership. Regression samples are at the firm × year × neighboring county pair level and restricted to firms within 10 kilometers from the border of neighboring counties. *LnMinWage* is the natural logarithm of the end-of-year monthly minimum wage in each county in the previous year. *SOE* is an indicator that equals one if firm is registered as state-owned, and zero otherwise. Columns (1), (2), and (3) focus on the number of wastewater treatment capacities and columns (4), (5), and (6) focus on the wastewater treatment facilities. *WaterCapacity* is the wastewater treatment capacity in tons per day over industrial output. *WaterFacility* is the number of wastewater treatment facilities over industrial output. Firm controls (*LnAsset*, *Leverage*, and *Profitability*) and macro-economic controls (*GDP Per Capita* and *GDP Growth*) are included in regressions in all columns. In columns (1) and (4), and (2) and (5), samples are restricted to non-SOE and SOE firms, respectively. In columns (3) and (6), the main effect of SOE is also controlled. All specifications include firm, neighboring county pair, industry × year, and province × year fixed effects. Standard errors are clustered at the neighboring county pair level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	WaterCapacity			*WaterFacility*		
Variables	Non-SOE	SOE	Full Sample	Non-SOE	SOE	Full Sample
LnMinWage	-0.069**	-0.042	-0.045*	-0.191**	-0.145	-0.144*
	(-2.29)	(-0.83)	(-1.77)	(-2.11)	(-0.69)	(-1.77)
LnMinWage × SOE			0.021**			0.057**
			(2.50)			(2.07)
Controls	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
County Pair FE	YES	YES	YES	YES	YES	YES
Industry × Year FE	YES	YES	YES	YES	YES	YES
Province × Year FE	YES	YES	YES	YES	YES	YES
Observations	586,584	157,518	746,047	585,929	157,504	745,384
Adj. R-squared	0.655	0.649	0.641	0.457	0.576	0.486

Table VII Minimum Wages and Pollution Emission: Cross-Section

This table presents the OLS regression results of minimum wages on firm's chemical oxygen demand (COD) emissions across different types of firms. Regression samples are at the firm × year × neighboring county pair level and restricted to firms within 10 kilometers from the border of neighboring counties. *LnMinWage* is the natural logarithm of the end-of-year monthly minimum wage in each county in the previous year. Panel A focuses on product market power which is measured by the industry's Lerner Index. For each firm, the Lerner Index is computed by dividing the difference between operating income and operating expense by operating income. In each year, firms are sorted by their industry wide Lerner Index. *PMC* is an indicator that equals one if the firm is in the high product market power industry in this year. Column (1) focuses on firms with low product market power (i.e., below median industry's Lerner Index) and column (2) focuses on firms with high product market power (i.e., above median industry's Lerner Index). Panel B focuses on firm's labor intensity which equals firm's total wage expenditure over total assets. In each year, firms are sorted by their industry wide labor intensity. *LaborIntensity* is an indicator that equals one if the firm is in the high labor intensity industry in this year. Column (1) focuses on low labor intensity firms (i.e., below median industry's labor intensity) and column (2) focuses on high labor intensity firms (i.e., above median industry's labor intensity). Panel C focuses on firm's average wage which equals firm's total wage expenditure over number of employees. In each year, firms are sorted by their industry wide average wage. *AverageWage* is an indicator that equals one if the firm is in the high average wage industry in this year. Column (1) focuses on low average wage firms (i.e., below median) and column (2) focuses on high average wage firms (i.e., above median). Panel D focuses on financial constraints which is proxied by firm size. *Small Firm* is an indicator that equals one if firm size above the sample median and zero otherwise. Column (1) focuses on larger firms (i.e., less financially constrained and *Small Firm* = 0) and column (2) focuses on smaller firms (i.e., more financially constrained and *Small Firm* = 1). Firm controls (*LnAsset*, *Leverage*, *Profitability*, and *LnIndOutput*) and macro-economic controls (*GDP Per Capita* and *GDP Growth*) are included in regressions in all columns. All specifications include firm, neighboring county pair, industry × year, and province × year fixed effects. The main effect of *PMC*, *LaborIntensity*, and *AverageWage* in the full sample regressions in Panel A, B, and C are absorbed by the industry × year fixed effects. The main effect of *Small Firm* is controlled in columns (3) of Panel D. Standard errors are clustered at the neighboring county pair level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Panel A: Product Market Power

	(1)	(2)	(3)
	Low Product Market Power	High Product Market Power	Full Sample
Variables	*LnCODEmission*	*LnCODEmission*	*LnCODEmission*
LnMinWage	0.639***	0.193	0.585***
	(3.14)	(1.21)	(3.96)
LnMinWage × PMC			-0.287***
			(-5.20)
Controls	YES	YES	YES
Firm FE	YES	YES	YES
County Pair FE	YES	YES	YES
Industry × Year FE	YES	YES	YES
Industry × Year FE	YES	YES	YES
Observations	512,841	417,440	935,594
Adj. R-squared	0.703	0.680	0.676

(*To be continued*)

Table VII Minimum Wages and Pollution Emission: Cross-Section - *continued*

Panel B: Labor Intensity

Variables	(1) Low Labor Intensity *LnCODEmission*	(2) High Labor Intensity *LnCODEmission*	(3) Full Sample *LnCODEmission*
LnMinWage	0.041	0.821***	0.397***
	(0.28)	(3.61)	(2.82)
LnMinWage × *LaborIntensity*			0.151**
			(2.54)
Controls	YES	YES	YES
Firm FE	YES	YES	YES
County Pair FE	YES	YES	YES
Industry × Year FE	YES	YES	YES
Province × Year FE	YES	YES	YES
Observations	521,532	402,593	935,594
Adj. R-squared	0.689	0.707	0.676

Panel C: Average Wage

Variables	(1) Low Wage *LnCODEmission*	(2) High Wage *LnCODEmission*	(3) Full Sample *LnCODEmission*
LnMinWage	0.491***	0.354*	0.516***
	(3.00)	(1.84)	(3.57)
LnMinWage × *AverageWage*			-0.141***
			(-2.60)
Controls	YES	YES	YES
Firm FE	YES	YES	YES
County Pair FE	YES	YES	YES
Industry × Year FE	YES	YES	YES
Province × Year FE	YES	YES	YES
Observations	527,946	399,763	935,594
Adj. R-squared	0.725	0.680	0.676

Panel D: Financial Constraints

Variables	(1) Less Financial Constraint *LnCODEmission*	(2) More Financial Constraint *LnCODEmission*	(3) Full Sample *LnCODEmission*
LnMinWage	0.283*	0.569***	0.147
	(1.88)	(2.81)	(1.03)
LnMinWage × *Small Firm*			0.557***
			(17.77)
Controls	YES	YES	YES
Firm FE	YES	YES	YES
County Pair FE	YES	YES	YES
Industry × Year FE	YES	YES	YES
Province × Year FE	YES	YES	YES
Observations	471,491	459,787	935,594
Adj. R-squared	0.681	0.692	0.677

Table VIII Minimum Wages, Pollution Charges and Industrial Pollution

This table presents the COD and SO_2 pollution fee changes across different provinces in China and the OLS regression results of minimum wages on firm's COD and SO_2 emissions across different levels of pollution fees. There are no pollution fees before 2003. Since July 1st 2003, the COD emissions were charged 0.7/kg, while the pollution fees of SO_2 emissions were increased to 0.63/kg in three years (i.e., the SO_2 emissions fees were 0.21/kg on July 1st 2003, 0.42/kg on July 1st 2004, and 0.63/kg on July 1st 2005, respectively). This policy applies to all businesses operating in Mainland China. Panel A and Panel B present the pollution fee adjustment dates and changes in per kilogram pollution charges for COD and SO_2 across different provinces from 2003 to 2013. Regression results are reported in Panel C. Regression samples are at the firm × year × neighboring county pair level and restricted to firms within 10 kilometers from the border of neighboring counties. *LnMinWage* is the natural logarithm of the end-of-year monthly minimum wage in each county in the previous year. *LnCODEmission* is the natural logarithm of one plus firm's COD emission in kilograms. *$LnSO_2Emission$* is the natural logarithm of one plus firm's sulfur dioxide (SO_2) emission in kilograms. *CODCharges* and *$SO_2Charges$* are the per kilograms pollution fees for COD and SO_2 at the end of the year, respectively. Firm controls (*LnAsset*, *Leverage*, *Profitability*, and *LnIndOutput*) and macro-economic controls (*GDP Per Capita* and *GDP Growth*) are included in regressions in all columns. All specifications include firm, neighboring county pair, industry × year, and province × year fixed effects. The main effect of *CODCharges* and *$SO_2Charges$* are absorbed by the province × year fixed effects. Standard errors are clustered at the neighboring county pair level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Panel A: COD Discharge Fees

Province	Adjustment Date	Before Adjustment	After Adjustment
Guangdong	2010.04.01	0.7/kg	1.4/kg
Hebei	2008.07.01	0.7/kg	1.1/kg
	2009.07.01	1.1/kg	1.4/kg
Jiangsu	2007.07.01	0.7/kg	0.9/kg
Liaoning	2010.08.01	0.7/kg	1.4/kg
Shandong	2008.07.01	0.7/kg	0.9/kg
Shanghai	2008.06.01	0.7/kg	1/kg
Xinjiang	2012.08.01	0.7/kg	1.4/kg
Yunnan	2009.09.01	0.7/kg	1.4/kg

Panel B: SO_2 Discharge Fees

Province	Adjustment Date	Before Adjustment	After Adjustment
Anhui	2008.01.01	0.63/kg	0.84/kg
	2009.01.01	0.84/kg	1.05/kg
	2010.01.01	1.05/kg	1.26/kg
Guangdong	2010.04.01	0.63/kg	1.26/kg
Guangxi	2009.01.01	0.63/kg	0.95/kg
	2010.01.01	0.95/kg	1.26/kg
Hebei	2008.07.01	0.63/kg	1/kg
	2009.07.01	1/kg	1.26/kg
Heilongjiang	2012.08.01	0.63/kg	0.95/kg
	2013.08.01	0.95/kg	1.26/kg
Inner Mongolia	2008.07.10	0.63/kg	0.95/kg
	2009.01.01	0.95/kg	1.26/kg
Jiangsu	2007.07.01	0.63/kg	1.26/kg
Liaoning	2010.08.01	0.63/kg	1.26/kg
Shandong	2008.07.01	0.63/kg	1.26/kg
Shanghai	2009.01.01	0.63/kg	1.26/kg
Shanxi	2008.04.01	0.63/kg	1.26/kg
Tianjin	2010.12.20	0.63/kg	1.26/kg
Xinjiang	2012.08.01	0.63/kg	1.26/kg
Yunnan	2009.01.01	0.63/kg	0.95/kg
	2010.01.01	0.95/kg	1.26/kg

(To be continued)

Table VIII Minimum Wages, Pollution Charges and Industrial Pollution - *continued*

Panel C: Pollution Discharge Fees

Variables	(1) *LnCODEmission*	(2) *$LnSO_2Emission$*
LnMinWage	0.804***	0.644***
	(4.14)	(4.51)
LnMinWage × *CODCharges*	-0.597**	
	(-2.50)	
LnMinWage × *$SO_2Charges$*		-0.605***
		(-3.08)
Controls	YES	YES
Firm FE	YES	YES
County Pair FE	YES	YES
Industry × Year FE	YES	YES
Province × Year FE	YES	YES
Observations	935,594	935,590
Adj. R-squared	0.676	0.840

Table IX Minimum Wages, Aggregate Pollution Emission, and Performance

This table presents the regression results of minimum wages on counties' aggregate COD emission and average industrial firms' profitability. Regression samples are at the county × year × neighboring county pair level. *LnMinWage* is the natural logarithm of the end-of-year monthly minimum wage in each county in the previous year. *LnCODEmission* is the natural logarithm of one plus total COD emission across all firms in each county. *SOERatio* is percentage of firms that are registered as SOE in each county. The main effect of *SOERatio* is controlled in all columns. In columns (2) and (4), *GDP Per Capita*, *GDP Growth*, and *LnAvgIndOutput* are further controlled in the regression. *GDP Per Capita* and *GDP Growth* are the GDP over total population and GDP growth in the city where the county is located, respectively. *LnAvgIndOutput* is the natural logarithm of total industry output across all industrial firms in each county. All specifications include county, neighboring county pair, and province × year fixed effects. Standard errors are clustered at the neighboring county pair level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Variables	(1) *LnCODEmission*	(2) *LnCODEmission*	(3) *Profitability*	(4) *Profitability*
LnMinWage	0.622***	0.405***	-2.557***	-1.371*
	(4.58)	(3.37)	(-3.32)	(-1.80)
LnMinWage × SOERatio	-0.535***	-0.565***	-1.446***	-1.685***
	(-4.87)	(-5.47)	(-3.06)	(-3.33)
Controls	NO	YES	NO	YES
County FE	YES	YES	YES	YES
County Pair FE	YES	YES	YES	YES
Province × Year FE	YES	YES	YES	YES
Observations	212,416	205,118	198,795	191,588
Adj. R-squared	0.543	0.609	0.461	0.470

Internet Appendix for

Minimum Wages, State Ownership, and Corporate Environmental Policies

Tao Chen

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Xi Xiong

Economics and Management School, Wuhan University

Kunru Zou

School of Finance, Renmin University of China

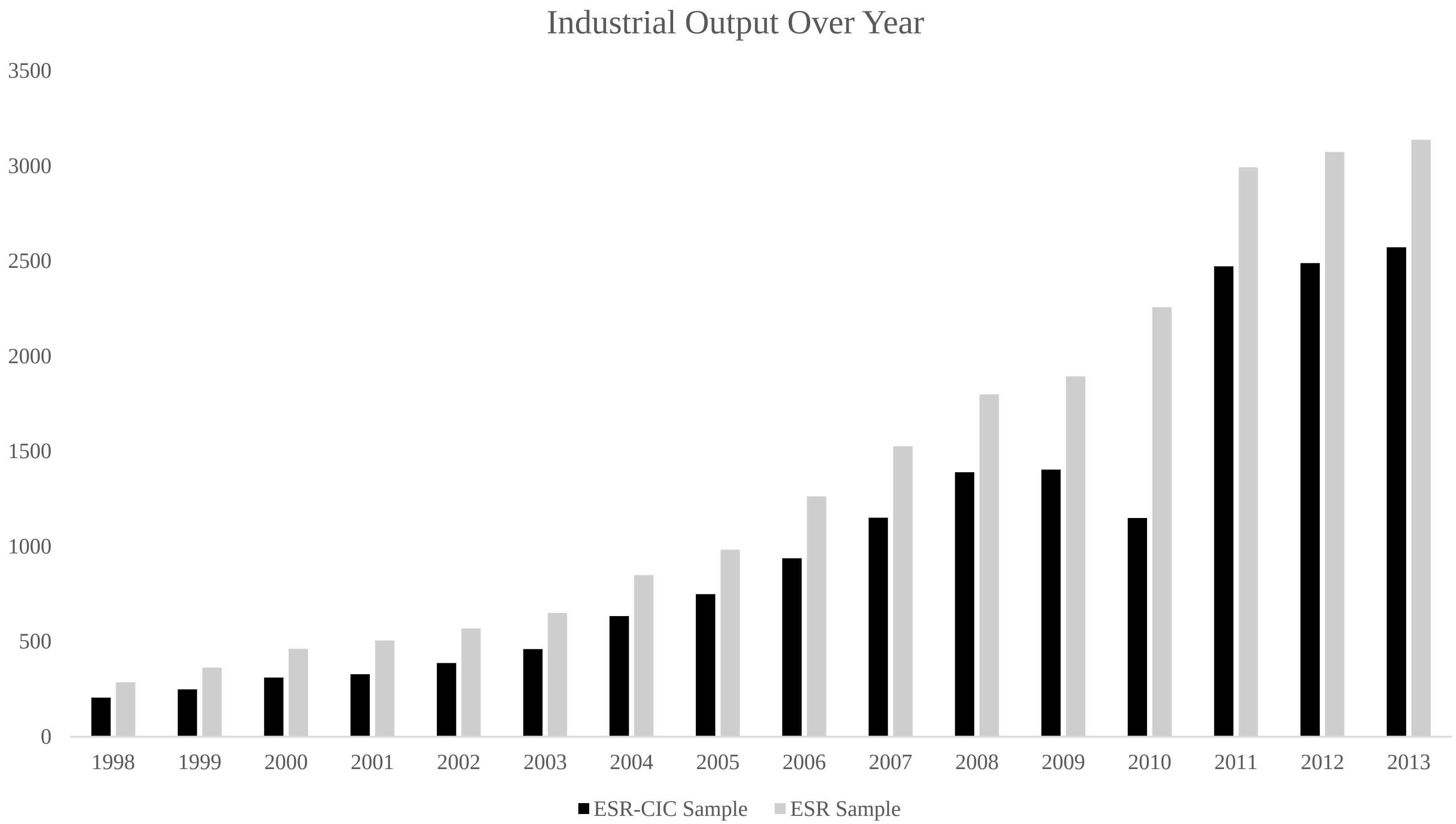

Figure A1. Industrial output over year. This figure plots the total industrial output of firms in the ESR-CIC matched sample and the ESR sample from 1998 to 2013. The grey bar denotes the total industrial output (in 10 billion RMB) for all firms covered in the ESR sample, while the black bar denotes the total industrial output (in 10 billion RMB) for all firms mutually covered by ESR and CIC database.

Table A1. Minimum Wages and Pollution Emission (Average Minimum Wages)

This table presents the OLS regression results of minimum wages on firm's chemical oxygen demand (COD) emissions. Regression samples are at the firm × year × neighboring county pair level. The dependent variable *LnCODEmission* is the natural logarithm of one plus firm's COD emission in kilograms. The independent variable of interest *LnMinAvgWage* is the natural logarithm of the average monthly minimum wage in each county in the previous year. In columns (1) and (2), (3) and (4), and (5) and (6), samples are restricted to firms located within 5, 10, 15 kilometers from the border of neighboring counties, respectively. In columns (2), (4), and (6), firm and macro-economic controls are included in the regression. The firm-level controls include the firm's total assets, leverage, profitability, and industrial output. Macro-economic controls include the GDP per capita and GDP growth of the city where the firm is located. All specifications include firm, neighboring county pair, industry × year, and province × year fixed effects. Standard errors are clustered at the neighboring county pair level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

	5 KM		10 KM		15 KM	
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	*LnCODEmission*	*LnCODEmission*	*LnCODEmission*	*LnCODEmission*	*LnCODEmission*	*LnCODEmission*
LnMinAvgWage	0.792***	0.754***	0.733***	0.724***	0.806***	0.786***
	(3.50)	(3.34)	(4.71)	(4.60)	(6.13)	(5.93)
LnAsset		0.204***		0.198***		0.191***
		(15.08)		(20.53)		(24.26)
Profitability		0.003***		0.003***		0.003***
		(5.09)		(7.57)		(8.94)
Leverage		-0.003		0.011		0.014
		(-0.08)		(0.48)		(0.74)
LnIndOutput		0.229***		0.241***		0.253***
		(30.03)		(41.23)		(49.93)
GDP Per Capita		-0.007***		-0.006***		-0.006***
		(-3.74)		(-3.58)		(-3.81)
GDP Growth		0.504**		0.500***		0.505***
		(2.18)		(2.89)		(3.50)
Firm FE	YES	YES	YES	YES	YES	YES
County Pair FE	YES	YES	YES	YES	YES	YES
Province Year FE	YES	YES	YES	YES	YES	YES
Industry Year FE	YES	YES	YES	YES	YES	YES
Observations	515,759	482,626	1,042,554	971,169	1,535,856	1,425,605
Adj. R-squared	0.646	0.657	0.659	0.670	0.669	0.681

Table A2. Minimum Wages and Pollution Emission (Firm-Year)

This table presents the OLS regression results of minimum wages on firm's chemical oxygen demand (COD) emissions. Regression samples are at the firm × year level. The dependent variable *LnCODEmission* is the natural logarithm of one plus firm's COD emission in kilograms. The independent variable of interest *LnMinWage* is the natural logarithm of the end-of-year minimum monthly wage in each county in the previous year. *LnMinAvgWage* is the natural logarithm of the average monthly minimum wage in each county in the previous year. In columns (2) and (4), firm and macro-economic controls are included in the regression. The firm-level controls include the firm's total assets, leverage, profitability, and industrial output. Macro-economic controls include the GDP per capita and GDP growth of the city where the firm is located. All specifications include firm and year fixed effects. Standard errors are clustered at the firm level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Variables	(1) *LnCODEmission*	(2) *LnCODEmission*	(3) *LnCODEmission*	(4) *LnCODEmission*
LnMinWage	0.346***	0.266***		
	(7.02)	(5.38)		
LnMinAvgWage			0.542***	0.447***
			(8.82)	(7.16)
LnAsset		0.201***		0.203***
		(17.60)		(17.77)
Profitability		0.002***		0.002***
		(5.70)		(5.59)
Leverage		0.026		0.015
		(0.88)		(0.49)
LnIndOutput		0.289***		0.289***
		(51.44)		(51.98)
GDP Per Capita		-0.004***		-0.004***
		(-6.29)		(-6.64)
GDP Growth		1.003***		0.951***
		(9.16)		(8.85)
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	515,191	473,940	533,441	490,061
Adj. R-squared	0.600	0.611	0.594	0.605

Table A3. Minimum Wages, State-Ownership, and Pollution Emission (Firm-Year)

This table presents the OLS regression results of minimum wages on firm's industrial emissions across different types of ownership. Regression samples are at the firm × year level. *LnMinWage* is the natural logarithm of the end-of-year monthly minimum wage in each county in the previous year. *SOE* is an indicator that equals one if firm is registered as state-owned, and zero otherwise. *LnCODEmission* is the natural logarithm of one plus firm's COD emission in kilograms. *$LnSO_2Emission$* is the natural logarithm of one plus firm's sulfur dioxide (SO_2) emission in kilograms. *$LnNH_3$-NEmission* is the natural logarithm of one plus firm's ammonia nitrogen (NH_3-N) emission in kilograms. *$LnNO_xEmission$* is the natural logarithm of one plus firm's nitrogen oxide (NO_x) emission in kilograms. *LnGasDischarge* is the natural logarithm of one plus firm's industrial waste gas discharged in 10,000 cubic meters. All specifications include the main effect of *SOE*, firm and macro-economic controls. The firm-level controls include the firm's total assets, leverage, profitability, and industrial output. Macro-economic controls include the GDP per capita and GDP growth of the city where the firm is located. All specifications include firm and year fixed effects. Standard errors are clustered at the firm level. T-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Variables	(1) *LnCODEmission*	(2) *$LnSO_2Emission$*	(3) *$LnNH_3$-NEmission*	(4) *$LnNO_xEmission$*	(5) *LnGasEmission*
LnMinWage	0.321***	0.208***	0.133***	0.208***	0.174***
	(6.39)	(4.36)	(2.81)	(3.04)	(4.57)
LnMinWage × SOE	-0.256***	-0.454***	-0.351***	-0.079	-0.460***
	(-4.60)	(-8.31)	(-6.33)	(-0.64)	(-10.80)
Controls	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Observations	473,939	473,938	434,330	300,142	363,656
Adj. R-squared	0.611	0.800	0.622	0.755	0.784