Article

Investigating the ‘Short Pain’ and ‘Long Gain’ Effect of Environmental Regulation on Financial Performance: Evidence from Chinese Listed Polluting Firms

Xiaoting Liu ¹ , Jichang Dong ^{1,2}, Kangxian Ji ¹, Xiuting Li ^{1,2,*} and Shijie Xu ^{1,*}

¹ School of Economics and Management, University of Chinese Academy of Sciences, Beijing 100190, China; liuxiaoting17@mailsucas.ac.cn (X.L.); jcdonglc@ucas.ac.cn (J.D.); jikangxian17@mailsucas.ac.cn (K.J.)

² Key Laboratory of Big Data Mining and Knowledge Management, Chinese Academy of Sciences, Beijing 100190, China

* Correspondence: lixiuting@ucas.ac.cn (X.L.); xsj@zjut.edu.cn (S.X.); Tel.: +86-138-1158-0462 (X.L.); +86-188-1179-8337 (S.X.)

Abstract: Environmental regulation affects the financial performance of firms, while the findings are mixed. This paper quantitatively analyzes the current and lagged effect of environmental regulation (ER) on financial performance (FP), based on the data of 361 highly polluting A-shares firms and 936 mildly polluting A-shares firms in China. It is proved that ER exerts a negative effect on the FP of polluting firms in the short term and a positive effect in the long term, which unifies the ‘Porter Hypothesis’ (PH) and the ‘Costly Regulation Hypothesis’ (CRH) on the temporal dimension. Mechanism analysis reveals that ER negatively affects current FP of highly polluting firms by improving their green innovation investment. In addition, ER has a significant positive lagged effect on the FP of polluting firms by improving their operating efficiency, rather than reducing production costs. Furthermore, we find that ER significantly improves the FP of highly polluting firms, especially state-owned firms, as opposed to mildly polluting firms and privately-owned firms. The conclusions imply that government should make subsidies for green firms or firms going green, and firms should pay more attention to green innovation investment and green development.

Keywords: environmental regulation (ER); financial performance (FP); lagged effect; mechanism analysis; heterogeneity

Citation: Liu, X.; Dong, J.; Ji, K.; Li, X.; Xu, S. Investigating the ‘Short Pain’ and ‘Long Gain’ Effect of Environmental Regulation on Financial Performance: Evidence from Chinese Listed Polluting Firms. *Sustainability* **2022**, *14*, 2412. <https://doi.org/10.3390/su14042412>

Academic Editor: Klaus Reiner Schenk-Hoppé

Received: 22 January 2022

Accepted: 17 February 2022

Published: 20 February 2022

Publisher’s Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Environmental regulation (ER) has contributed a lot to environmental protection [1], but has encountered some obstacles from major polluters [2] because of the direct and opportunity costs incurred by ER [3–5]. Thus, it is an important task for governments to explore the effect of ER on financial performance (FP) of highly polluting firms and then guide these firms to go green. ER has become a significant topic for many countries all over the world, especial for China, which has created a special green sector in the green-development era. This research ultimately is aimed at boosting the greenness of China and other countries implementing ER for environmental protection.

There is a massive amount of research on the effect of ER on the FP of firms, but the findings are mixed. The Porter Hypothesis (PH) and its proponents argue that ER can increase the research and development (R&D) investment and innovation level of firms [6], and then improve their productivity [7–10] and FP [11–15]. However, the Costly Regulation Hypothesis (CRH) and its proponents argue that ERs are trying to reduce the negative external affect caused by business, which increases the costs of compliance for the firms and thus reduces their productivity and FP [16–20].

The differences in the two hypotheses stem from the different lengths of time studied. While ER increases the costs of environmental compliance and reduces FP of major polluters in the short term, it is conducive to improving FP of firms in the long term [21–24].

Therefore, this paper will shed light on the short-term and long-term impacts of ER on FP based on polluting A-shares firms, which are firms listed on either the Shanghai or Shenzhen Stock Exchange and whose shares are traded in Renminbi by domestic investors in China. The results reveal that ER significantly reduces the FP of polluting firms in the current period, but improves FP in the two to three periods that follow, which unifies PH and CRH on the temporal dimension. (In China, the fiscal year is the same as the calendar year, running from 1 January to 31 December. We will adopt ‘current period’ to refer to both simultaneously and to avoid confusion.) The conclusions still hold when the model and core variables are changed, and an exogenous instrumental variable are involved to make IV (Instrumental Variables)–2SLS (Two-stages Least Squares) analysis.

In addition, we make mechanism analysis by exploring the current and lagged effect of ER on the firms’ operating efficiency, production costs, and innovation investment. The results verify that ER exerts negative effects on the current FP of highly polluting firms by improving their green innovation investment. The positive impact of ER on FP in the two to three periods that follow is mainly realized by improving operational efficiency of pollutants.

Furthermore, given that the impact of ER varies with firms’ pollution levels and ownership types [14], we explore the heterogeneity of the ER effects on FP of firms in highly polluting industries versus mildly polluting industries and FP of state-owned firms versus private firms. The results show that ER mainly affects state-owned and highly polluting firms, while the effects are nonsignificant for private and mildly polluting firms.

This paper contributes to the existing research in the following three ways. First, this paper explores the different impacts of ER on the FP of polluting firms on the temporal dimension. We empirically explore the negative and current impacts and positive but lagging impacts of ER on FP, which unify CRH and PH. Second, this paper contributes to the literature by investigating the mechanism and heterogeneity of the effects of ER on FP. We found ER significantly improves the green innovation investment of highly polluting firms while simultaneously reducing their FP. However, FP, in the following two to three periods, can be promoted by improvements in firms’ operational efficiency. Furthermore, we found the impacts of ER on FP of mildly polluting and privately-owned firms are nonsignificant. Third, the results show the ‘short pain’ and ‘long gain’ effect of ER on the FP of highly polluting firms, which provides implications to governments and the firms, and helps to understand ER dialectically.

The rest of the paper proceeds as follows. Section 2 surveys the literature and proposes hypotheses. Section 3 introduces empirical strategies and data. Section 4 is the empirical results and analysis. Sections 5 and 6 further discuss the mechanism and heterogeneity of ER effect on FP. Section 7 concludes.

2. Literature and Hypotheses

In the first half of the 20th century, environmental pollution has gradually become one of the focuses around the world, such as the photochemical pollution incident in the United States in the 1950s, the smog incident in London, and the Minamata disease in Japan. Since the 1970s, many countries have begun to implement environmental regulations to alleviate the environmental pollution, and related research has to be increasingly rich.

2.1. The Effect of ER on FP of Firms

There are two major hypotheses regarding the effect of ER on the FP of firms: Porter Hypothesis (PH) and Costly Regulation Hypothesis (CRH). PH holds that ER can improve FP. PH is named after M. E. Porter [6], who was the first to propose that a properly designed ER could stimulate innovation, thus making products more competitive. Porter and van der Linde [7] further examined the environment–competitiveness relationship through theoretical and case study approaches and argued that it did not have to involve a trade-off between regulation and competitiveness. Jaffe and Palmer [17] divided PH into the weak version, the strong version, and the narrow version and argued that only under the strong

version can regulation induce innovation with benefits exceeding the compliance costs. Following these studies from the 1990s, Berman and Bui [8], Ambec and Barla [9], Rassier and Earnhart [25], and Jefferson et al. [10] verified PH by constructing theoretical and/or empirical models.

CRH, on the other hand, argues that ER increases the costs of compliance and thus negatively affects FP. Palmer et al. [3] argue that PH is premised on two hard-to-fulfill presumptions: first, the private sector systematically overlooks opportunities for profitable innovation; second, there is some regulatory authority that can make the private sector realize these opportunities for profit from innovation. Jaffe et al. [16], Wagner et al. [18], and Lanoie et al. [20] rejected the existence of PH based on data from the U.S., Europe, and OECD, respectively. The literature studying developing countries such as China has also verified the validity of CRH by exploring the negative effects of ER on innovation investment [26], total factor productivity (TFP) [14], and financial performance [27].

Some scholars have offered explanations for the different impacts of ER on the innovation or productivity of firms. One strand in the literature explores the heterogeneous effects of different types of ER. For example, Zhao et al. [28] argued that administrative ER had a more significant effect on the technological innovation of firms, while market-based ER was more conducive to green transformation. Xie et al. [5] reached the same conclusion by exploring the effects of command-and-control and market-based ER on productivity of firms. Another strand in the literature explains the difference from the firms' perspective. For example, Rassier and Earnhart [11] distinguished the ER effects on actual profitability and expected profitability of firms. In addition, some studies attributed the heterogeneity to the different types of firms, such as the highly polluting firms versus mildly polluting firms or state-owned firms versus private firms [14,29].

However, the above-mentioned studies barely considered the lagged effects of ER. Rassier and Earnhart [25] confirmed the short-run and long-run positive effect of Clean Water Act regulation on FP based on quarterly data. However, there may be heterogeneity in the effects of ER on FP of firms in different years. ER increases the compliance costs and reduces total factor productivity (TFP) as well as the book value of firms in the current period [23], but under the ER constraint, profit-maximizing firms are likely to adjust their production and operation strategies to reduce their costs, which will have a positive effect on the production efficiency, operating performance, and value of firms in future periods [21–24]. Based on the above analysis, Hypotheses 1a and 1b are proposed.

Hypothesis 1a. *The effect of ER on the firm's current FP conforms with CRH, i.e., ER significantly reduces the firm's current FP.*

Hypothesis 1b. *The effect of ER on the firm's future FP conforms with PH, i.e., ER significantly increases the firm's future FP.*

2.2. Mechanism Analysis

CRH can be used to summarize the effect of ER on current FP. Based on the findings of Rassier and Earnhart [11] and Tang et al. [14], ER increases the current costs of firms, including fines, green innovation investment, etc., and thus reduces current FP, which is only partially offset by incentives such as green loan schemes and tax breaks for companies that go green. In addition, increased ER may reduce financial institutions' expectations of polluters' future profitability, thus increasing their loan costs and reducing their FP. Furthermore, intensified ER may force polluters to shut down some polluting production lines and thus reduce their current operating efficiency. Therefore, the following Hypotheses 2a and 2b can be proposed.

Hypothesis 2a. *ER increases the current production costs of polluting firms and decreases their current FP.*

Hypothesis 2b. *ER increases the current green inputs of polluting firms and decreases their current FP.*

The positive impact of ER on the future FP of firms has been discussed from the perspective of reducing production costs and increasing sales profits. For instance, Porter and van der Linde [7] argued that ER can lead to technological innovations that improve production efficiency, thus reducing production costs while improving product quality, which will ultimately improve firms' profitability and competitiveness. Rassier and Earnhart [11] outlined three pathways through which ER affects firms' profitability: improving innovation efficiency and revenue, reducing costs, and improving operational efficiency. Hu et al. [30] and Xing et al. [31] confirmed that ER improved the FP of firms by increasing their green innovation capacity. Based on the above analysis, we propose the following three hypotheses.

Hypothesis 3a. *ER improves the future FP of polluting firms by reducing their production costs.*

Hypothesis 3b. *ER improves the future FP of polluting firms by increasing their operational efficiency.*

Hypothesis 3c. *ER improves the future FP of polluting firms by improving their investment in green innovation.*

2.3. Heterogeneity Analysis

Studies have been conducted to verify the heterogeneity of the effect of ER on the FP of different types of firms. For example, Hering and Poncet [29] and Tang et al. [14] found that the negative effects of ER on TFP and innovation are exacerbated for enterprises in more heavily polluting industries, those of smaller size, and those owned by foreign companies. This paper explores the heterogeneity of the effect of ER on FP from two perspectives: whether the firm is in a highly polluting industry and the ownership of the firm.

In 2008, China's Ministry of Environmental Protection (MEP) issued the Directory of Categorized Environment Inspection of Public Companies (Letter of the MEP General Office [2008] No. 373), which classified 14 industries as highly polluting industries. The Directory provides a standard and basis for regulation. Considering that the targets of environmental regulation are mainly heavy polluters [32], we therefore propose Hypothesis 4a.

Hypothesis 4a. *ER has a more pronounced effect on the FP of firms in highly polluting industries than on those in mildly polluting industries.*

State-owned firms are generally more likely to have access to resources and advice from officials, and they bear more social responsibilities than private firms. In addition, state-owned firms are more able to take risks with projects such as green innovation than a private company because they can easily receive support from the government when they lose money. Thus, the effect of ER on state-owned firms in highly polluting industries may be more significant. Therefore, Hypothesis 4b is proposed. The theoretical framework is shown in Figure 1.

Hypothesis 4b. *The positive effect of ER on the future FP of state-owned firms in highly polluting industries is significantly greater than that on private firms.*

To illustrate the above hypotheses, we can answer the following three questions. Firstly, how ER impacts the FP of highly polluting firms in the short run and long run. Secondly, how ER impacts the FP of highly polluting firms, according to green innovation, operation, or production improvement. Thirdly, how the impacts vary for highly polluting firms and mildly polluting firms, for firms with different ownerships, and on actual profitability and

expected profitability. The answers will unify PH and CRH on the temporal level and provide targeted recommendations for highly polluting firms and governments.

Figure 1. Diagram of ER on current FP and future FP of highly polluting firms. ER: environmental regulation; FP: financial performance.

3. Data and Empirical Strategy

3.1. Variables and Data Sources

3.1.1. Independent Variables

Existing research measures ER in the following three ways: first, input-based indicators, such as pollution abatement costs, pollution treatment investment, number of regulatory inspections, and government environmental protection expenditures [32,33], etc.; second, performance-based indicators, such as sewage tax and fees, emissions, or disposal rates of major pollutants [34,35], etc.; third, the environmental policies released [36,37]. In addition, some studies combine multiple indicators to construct a comprehensive system to evaluate ER.

In this paper, we mainly refer to the second way, since we are not concerned with how or by whom the ER implemented, but instead focus on the efficacy of ER and measure ER in a performance-based way, which is also suggested in the study of Zhao and Sun [38] based on a comparison of the above-mentioned measurements of ER in terms of reasonability and data availability. Thus, following the method proposed by Zhao and Sun [38] and Shen et al. [39], we construct an indicator to describe the intensity of ER by the removal rates of pollutants, e.g., SO₂ and industrial smoke (dust) at the city level. The ER in this paper only ranges from 2011 to 2016 as the result of data availability, which will not affect the results and conclusions. The calculation process is divided into the following three steps.

- **Step 1: Normalization of variables**

The normalization process can be described as follows:

$$Base_{ij} = Removal_{ij} / Generate_{ij} = (Generate_{ij} - Emission_{ij}) / Generate_{ij} \quad (1)$$

$$Base_{ij}^S = [Base_{ij} - \min(Base_{ij})] / [\max(Base_{ij}) - \min(Base_{ij})] \quad (2)$$

where $Base_{ij}$ is the removal rate of pollutant j for city i , $Removal_{ij}$, $Generate_{ij}$, and $Emission_{ij}$ are the removal amount, generated amount, and emission amount of pollutant j for city i . $\max(Base_{ij})$ and $\min(Base_{ij})$ are the maximum and minimum values of the removal rate of pollutant j for all cities, respectively, and $Base_{ij}^S$ is the normalized removal rate of pollutant j , which includes the SO₂ and industrial smoke (dust).

- **Step 2: Adjustment factor**

Considering that the emission levels of different pollutants in the same city are different and that the emission levels of the same pollutant in different cities are also different, the adjustment factor of pollutant j in the city i is calculated with Equation (3).

$$A_{ij} = \frac{Emission_{ij}}{Emission_{Cj}} / \frac{GDP_i}{GDP_C} \quad (3)$$

where A_{ij} is the adjustment factor of city i corresponding to the pollutant j , $Emission_{ij}$ denotes the emission of pollutant j in city i , $Emission_{Cj}$ is the total emission of pollutant j of all cities, GDP_i and GDP_C denote the GDP of the city i and the nation, respectively.

- **Step 3: ER**

We calculated the ER of city i based on the normalized removal rates of two pollutants and the adjustment factors by the Equation (4) as follows:

$$ER_i = \sum_{j=1}^2 Base_{ij}^S * A_{ij} / 2 \quad (4)$$

where ER_i is the ER for city i , and the number 2 indicates that two pollutants are considered in our calculation process.

The data of removal amount, generated amount, and emission amount of SO₂ and industrial smoke (dust) are obtained from the China City Statistical Yearbook.

3.1.2. Dependent and Other Variables

Dependent variables: Return on Assets (ROA) and Return on Equity (ROE) are applied to measure FP of firms.

Mediating variables: The mediating variables are the firm's operating costs' rate, total asset turnover rate, and the number of green patent applications.

Control variables: Referring to Rassier and Earnhart [11] and Tang et al. [14], we selected firm-level variables, including firm size, firm age, capital density, revenue and profit growth rate, asset-liability ratio, earned interest multiple ratio, and the proportion of researchers as control variables.

In addition, considering that factors particular to each city, such as pollution level [14,33], economic development, and fiscal decentralization degree, may affect both ER and FP, we added such indicators as city pollution, per capita GDP, and fiscal decentralization degree to alleviate the endogeneity problem. (Referring to Liu and Lin [40]), we constructed a total pollutant emission index based on SO₂ emission, industrial smoke (dust) emission, and industrial wastewater discharge. The specific calculation process and results are kept for future reference.) Definitions and calculations of variables are shown in Table 1.

Table 1. Variable definitions.

Variable	Definition and Calculation
Independent variable	
<i>ER</i>	Environmental regulation
Dependent variables	
<i>ROA</i>	Return on Assets
<i>ROE</i>	Return on Equity
Mediating variables	
<i>Ope_Cost</i>	Operating costs rate = operating costs / operating revenue
<i>TAT</i>	Total assets turnover rate = Total Operating Revenue × 2 / (Total Assets at the beginning of the period + Total Assets at the end of the period)

Table 1. *Cont.*

Variable	Definition and Calculation
<i>Green_Patent</i>	Number of green patent applications, including the green invention and green utility model
Control variables	
<i>lnAsset</i>	The logarithm of total assets
<i>lnAge</i>	The logarithm of the firm age
<i>Capital_Density</i>	Asset Density = Total Assets / Total Operating Revenue
<i>Growth_Income</i>	Annual growth rate of total operating revenue
<i>Growth_Profit</i>	Annual growth rate of net profit
<i>Asset_Liability</i>	Asset-liability ratio
<i>Interest_Multiple</i>	Earned interest multiple ratio
<i>Pro_R&D</i>	Percentage of personnel employed for R&D purposes
<i>Pollution</i>	City pollution index, referring to the calculation methodology of Liu and Lin [40]
<i>Pgdp</i>	Per capita GDP
<i>Fiscal</i>	Degree of fiscal decentralization

This table shows the definition and calculation of main variables in this paper, including the dependent variables, independent variables, and the control variables. We include control variables about firm-level characteristics as well as regional-level characteristics.

Firm-level indicators of FP and control variables are obtained from the CSMAR database. The data on green innovation are obtained from the State Intellectual Property Office of China. We match the city-level data and firm-level data using the registered addresses of firms.

3.2. Identification of Highly Polluting Firms

According to the Directory of Categorized Environment Inspection of Public Companies (Letter of the MEP General Office (2008) No. 373) and 2017 Industrial Classification for National Economic Activities (GB/T4754-2017), ER mainly targets highly polluting industries [32], such as the manufacturing and smelting industries. We define 143 four-digit SIC industries, including thermal power generation, cement manufacturing, crude oil processing, petroleum products manufacturing, et al., as highly polluting industries.

A total of 891 companies listed on Shanghai Stock Exchange and/or Shenzhen Stock Exchange (excluding ST and *ST companies, which is a classification indicating abnormal performance or status) in the above industries, were selected. After excluding firms with missing financial data in any year from 2009 to 2016, we obtain balanced panel data of 361 highly polluting firms in our research period, with a total of 2888 observations.

3.3. Descriptive Statistics

To avoid problems with outliers, we winsorize these variables at the 1st and 99th percentiles. The descriptive statistics are shown in Table 2. It can be seen that the mean values of ROA and ROE of highly polluting firms in China from 2009 to 2016 are 5.482 and 8.982, respectively. Our primary variable of interest, ER, is positive with a mean value of 0.692 and a standard deviation of 0.706, and a minimum and maximum value of 0.007 and 4.253, respectively.

Table 2. Summary statistics.

Variable	Observations	Mean	Std	Min	Max
ROE	2888	8.982	13.995	−52.679	51.682
ROA	2888	5.482	6.814	−14.686	27.643
ER	2888	0.691	0.706	0.007	4.253
Ope_Cost	2888	73.220	19.283	17.180	103.870

Table 2. Cont.

Variable	Observations	Mean	Std	Min	Max
TAT	2888	0.801	0.494	0.120	2.758
Green_Patent	2888	0.810	5.328	0.000	236.000
lnAsset	2888	22.058	1.311	19.220	25.355
lnAge	2888	2.697	0.339	1.609	3.434
Capital_Density	2888	1.917	1.351	0.390	8.622
Growth_Income	2888	11.755	25.510	−42.838	107.783
Asset_Liability	2888	44.077	20.935	3.661	88.338
Interest_Multiple	2888	17.067	53.681	−9.182	428.202
Pro_R&D	2888	2.483	5.180	0.0000	22.330
Pollution	2888	0.825	0.375	0.165	1.958
Pgdp	2888	0.507	0.148	0.119	0.741
Fiscal	2888	10.874	0.586	9.456	12.030

This table shows descriptive statistics of main variables. The sample includes 2888 firm-year observations from 2009 to 2016.

3.4. Empirical Models

We first explore the effect of ER on FP in the current period and lagged period using Equation (5).

$$Profit_{ijt} = \beta_0 + \beta_1 ER_{it-n} + X_{ijt-1}\beta + v_i + \theta_t + \varepsilon_{ijt} \quad (5)$$

where $Profit_{ijt}$ denotes FP of firm j in region i in year t . Specifically, it includes ROA and ROE. ER_{it-n} denotes the ER in region i in year $t - n$, where $n = 0, 1, 2, 3$. We also control for other factors by adding X_{ijt-1} , which includes characteristics of the firm in year $t - 1$ as well as the regional characteristics such as pollution level, per capita GDP, and local fiscal strength. v_i and θ_t are the firm fixed effect and year fixed effect, respectively. ε_{ijt} is the idiosyncratic error term.

In addition, in order to explore the mechanism of ER on FP, we construct a mediating effect model to explore the mediating effects of production costs, operating efficiency, and green innovation, as shown in Equations (6) and (7).

$$Mediat_{ijt} = \alpha_0 + \alpha_1 ER_{it-n} + X_{ijt-1}\alpha + v_i + \theta_t + \varepsilon_{ijt} \quad (6)$$

$$Profit_{ijt} = \gamma_0 + \gamma_1 ER_{it-n} + \gamma_2 Med_{ijt} + X_{ijt-1}\gamma + v_i + \theta_t + \varepsilon_{ijt} \quad (7)$$

where Med_{ijt} is the mediating variable, including the firm's operating costs rate, total asset turnover rate, and the number of green patent applications.

4. Empirical Results and Analysis

4.1. Empirical Models

4.1.1. Negative Effects of ER on Current FP

We first explore the effect of ER on FP of highly polluting firms in the current period, and the results are shown in Table 3. With ROE as the dependent variable, the negative effect of ER on FP in the current period is not significant when no control variables are added (columns 1 and 2). In addition, the negative effect stays nonsignificant when control variables are added, but firm effects and year effects are not fixed (column 3). However, ER significantly reduces FP in the current period, when control variables are added, and firm effects (column 4) as well as year effects (column 5) are fixed. The conclusion still holds, when the dependent variable is changed to ROA, which verifies Hypothesis 1a, that ER significantly reduces the FP of highly polluting firms in the current period and the results are in line with Liu et al. [27].

Table 3. Effect of ER on FP of highly polluting firms in the current period.

Current Period Effect	(1)	(2)	(3)	(4)	(5)	(6)
	ROE	ROE	ROE	ROE	ROE	ROA
ER	−0.577 (−1.48)	−0.292 (−0.70)	−0.148 (−0.29)	−1.874 ** (−2.06)	−1.927 * (−1.96)	−0.941 ** (−2.14)
lnAsset		−0.447 * (−1.76)	−0.327 (−1.29)	−1.178 (−0.95)	−0.684 (−0.57)	−0.679 (−1.32)
lnAge		−4.565 *** (−5.49)	−3.313 *** (−3.84)	−18.924 *** (−5.21)	−18.739 *** (−2.79)	−8.363 *** (−2.67)
Capital_Density		−1.436 *** (−7.18)	−1.281 *** (−5.99)	−1.689 *** (−3.16)	−1.734 *** (−3.15)	−1.042 *** (−4.12)
Growth_Income		0.084 *** (7.07)	0.084 *** (7.16)	0.023 ** (2.01)	0.044 *** (3.45)	0.027 *** (5.01)
Asset_Liability		−0.061 *** (−3.62)	−0.066 *** (−3.97)	0.151 *** (5.36)	0.136 *** (4.95)	0.021 * (1.72)
Interest_Multiple		0.018 *** (4.61)	0.018 *** (4.67)	0.006 * (1.79)	0.005 (1.65)	0.004 ** (2.11)
Pro_R&D		0.096 ** (2.11)	0.164 *** (3.45)	0.347 *** (4.98)	0.046 (0.57)	0.019 (0.57)
lnPollution			−1.043 (−1.18)	4.343 ** (2.19)	4.67 ** (2.26)	1.886 ** (2.01)
lnPgdp			14.400 *** (4.18)	10.29 (1.58)	10.382 (1.55)	0.251 (0.10)
lnFiscal			−3.821 *** (−4.85)	−0.530 (−0.45)	1.21 (1.02)	0.146 (0.30)
Year FE	NO	NO	NO	NO	YES	YES
Firm FE	NO	NO	NO	YES	YES	YES
Constant	9.381 *** (27.01)	34.259 *** (6.64)	63.332 *** (7.87)	78.265 *** (3.71)	51.113 * (1.83)	41.220 *** (3.19)
R2	0.001	0.110	0.122	0.143	0.169	0.217
F	2.205	29.623	24.673	17.953	16.343	18.601
Observations	2888	2527	2527	2527	2527	2527

This table shows the effect of ER on the FP of highly polluting firms in the current period. In order to avoid the problem of reverse causality between firm-level control variables and FP, all firm-level control variables in this paper are at a one-period lag. The *t*-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

4.1.2. Negative Effects of ER on Future FP

Next, we investigate whether there is a significant effect of ER on FP in the future periods by including ER with a lag of one period, two periods, and three periods, respectively. As shown in Table 4, the effect of ER on FP with a lag of one period (column 1 and 2) and two periods (column 3 and 4) is not significant, but the signs of the two coefficients are opposite, while the effect of ER with a lag of three periods on FP is significantly positive (column 5 and 6), which verifies Hypothesis 1b that there is a lagged effect of ER on FP of highly polluting firms, and the results here indicate that the lag is three periods, which is consistent with Chen and Ma [24].

Table 4. Lagged effect of ER on the FP of highly polluting firms.

Lagged Effect	(1)	(2)	(3)	(4)	(5)	(6)
	ROE	ROA	ROE	ROA	ROE	ROA
L1.ER	−0.216 (−0.25)	−0.195 (−0.58)				
L2.ER			1.786 (1.48)	0.870 (1.63)		
L3.ER					2.086 ** (2.35)	0.836 ** (2.00)

Table 4. Cont.

Lagged Effect	(1)	(2)	(3)	(4)	(5)	(6)
	ROE	ROA	ROE	ROA	ROE	ROA
Control variables	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Constant	52.706 *	42.133 ***	40.342	24.515	52.288	11.732
	(1.86)	(3.25)	(0.97)	(1.35)	(1.16)	(0.64)
R ²	0.167	0.215	0.104	0.141	0.081	0.094
F	16.313	18.441	8.166	10.490	5.871	7.181
Observations	2527	2527	2166	2166	1805	1805

This table shows the lagged effect of ER on the FP of highly polluting firms. In order to avoid the problem of reverse causality between firm-level control variables and FP, all firm-level control variables in this paper are at a one-period lag. *L1.ER*, *L2.ER*, and *L3.ER* indicate the environmental regulations with a lag of one period, two periods, and three periods, respectively. Control variables are the same as those in Table 3. The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

4.2. Robustness Test

4.2.1. Alternative Models and Variables

We neglect the continuous nature and volatility of financial performance in the above empirical models. In addition, the interaction effects of environmental regulation in different periods are not considered. In this case, we overcome the above questions and verify the robustness of the above findings in the following three ways: (1) adding the dependent variables with the lag of one period, (2) taking the logarithms of the dependent variables, and (3) adding the independent variables of different periods at the same time [41].

The results in Table 5 show that when the dependent variables with a lag of one period are added and/or the logarithms of the dependent variables are taken, ER still has a significant negative effect on FP in the current period (column 1, 2, and 3), but a significant positive effect on FP in the future of three periods (column 4, 5, and 6). However, when both current and lagged ER are included, the negative effect of current ER on FP is not significant, but the positive effect of ER with a three-period lag on FP is still significant (column 7 and 8).

Table 5. Robustness analysis of the effect of ER on FP of highly polluting firms.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ROA	ROE	lnROE	ROA	ROE	lnROE	ROE	lnROE
<i>L1.ROA/ROE</i>	0.264 *** (9.18)	0.037 (0.75)	−0.058 (−1.11)	0.097 ** (2.50)	−0.151 ** (−2.56)	−0.235 *** (−3.84)	−0.151 ** (−2.55)	−0.235 *** (−3.83)
<i>ER</i>	−0.87 ** (−2.07)	−1.901 ** (−1.97)	−0.018 * (−1.67)				−1.04 (−0.90)	−0.009 (−0.69)
<i>L1.ER</i>							−1.491 (−1.41)	−0.018 (−1.42)
<i>L2.ER</i>							0.882 (0.88)	0.009 (0.82)
<i>L3.ER</i>				0.774 ** (2.01)	2.241 ** (2.27)	0.024 ** (2.09)	2.051 ** (2.18)	0.022 ** (2.03)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Constant	27.005 ** (2.46)	48.55 * (1.79)	5.223 *** (14.58)	12.700 (0.73)	39.772 (0.83)	5.916 *** (10.37)	46.949 (0.98)	6.006 *** (10.69)
R ²	0.269	0.170	0.127	0.102	0.100	0.115	0.102	0.117

Table 5. Cont.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ROA	ROE	lnROE	ROA	ROE	lnROE	ROE	lnROE
F	28.012	16.804	13.836	7.517	5.182	4.941	4.501	4.295
Observations	2527	2527	2527	1805	1805	1805	1805	1805

This table shows the robustness analysis of the effect of ER on the FP of highly polluting firms. In order to avoid the problem of reverse causality between firm-level control variables and FP, all firm-level control variables in this paper are at a one-period lag. *L1.ROA/ROE* indicates *ROA* or *ROE* with one period lagged. *L1.ER*, *L2.ER*, and *L3.ER* indicate the environmental regulations with a lag of one period, two periods, and three periods, respectively. Control variables are the same as those in Table 3. The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

4.2.2. Endogeneity Test

The endogeneity problem should be taken into consideration for the following reasons. First, ER and the profitability of the firm may be influenced by factors such as that region's level of status, financial resources, and economic development. Second, ER and FP of highly polluting firms can influence each other because taxes taken from highly polluting firms are closely related to their FP. Third, there may be some neglected factors that affect FP.

We address the endogeneity problem with the method proposed by Hering and Poncet [29]. Specifically, we select the air circulation coefficient, measured by the wind speed multiplied by the height of the boundary layer as an Instrumental Variable (IV) for ER. (The calculation of the air circulation coefficient is based on the wind speed and the boundary layer height data at a 10-m height on the global 0.750×0.750 grid provided by the European Centre for Medium-Range Weather Forecasts (ECMWF) and matched with latitude and longitude data for Chinese cities). In general, the stronger the air circulation, the more significant the pollution dispersion is, and therefore a more stringent ER is needed.

The results of the first stage calculation show that the air circulation coefficient is significantly positively related to ER, and both the F-value and the minimum eigenvalue statistic indicate that there are no weak instrument concerns. (In verifying the ER effect on FP in the current period, the coefficient of air circulation in the current period is positively correlated with ER at a significance level of 1% with a coefficient of 0.729. In verifying the lagged ER effect on FP, the coefficient of air circulation with a two-period lag is positively correlated at a significance level of 1% with a correlation coefficient of 0.466.) The second stage regression results from Table 6 show that although the negative effect of ER on the current *ROE* of polluting firms is nonsignificant, there is a significant negative effect on current *ROA* and *lnROA*. In addition, ER with a two-period lag significantly increases *ROA* and *ROE*. The effect with a three-period lag is no longer significant, which slightly deviates from the baseline results, but basically verifies the lagging positive effect of ER on FP.

Table 6. Effect of ER on FP of polluting firms (IV-2SLS).

Variable	(1)	(2)	(3)	(4)	(5)
	ROE	ROA	lnROA	lnROE	lnROA
ER	−6.876 (−1.25)	−4.659 ** (−2.06)	−0.044 ** (−2.03)		
L2.ER				0.220 ** (1.96)	0.068 * (1.94)
Control variable	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Constant	62.718 ** (2.27)	45.952 *** (4.09)	5.015 *** (47.43)	4.171 *** (5.99)	4.622 *** (20.94)

Table 6. Cont.

Variable	(1)	(2)	(3)	(4)	(5)
	ROE	ROA	lnROA	lnROE	lnROA
Robust F-value of the first stage	52.74	52.74	52.74	14.23	14.23
Minimum Eigenvalue Statistics	70.07	70.07	70.07	14.94	14.94
R ²	0.477	0.636	0.622	0.277	0.563
Observations	2527	2527	2527	2166	2166

This table shows the regression results of IV-2SLS to check the robustness of the effect of ER on the FP of highly polluting firms. In order to avoid the problem of reverse causality between firm-level control variables and FP, all firm-level control variables in this paper are at a one-period lag. *L2.ER* indicates the environmental regulations with a lag of two periods. Control variables are the same as those in Table 3. The Z-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively. The F-values and the minimum eigenvalue statistics are larger than 10, indicating that there are no weak instrument concerns.

5. Mechanism Analysis

We combined Equations (1)–(3) to explore the intrinsic mechanism of the effect of ER on FP from the perspectives of the production costs, operating efficiency, and green innovation of polluting firms.

5.1. Mechanism Analysis of ER Effects on Current FP

Considering that ER generally increases the compliance costs or green innovation input of polluting firms, we add the operating costs rate and the number of green patent applications to the model to explore the mechanism of ER effects on current FP. (The reason for choosing the number of green patent applications instead of R&D expenditure is that ER directly affects firms' green innovation, and the number of green patent applications directly reflects firms' investment in green innovation, while R&D expenses cover not only green innovation but also non-green innovation.) The regression results from Table 7 cannot support the positive effect of ER on the operating costs' rate (column 1 and 2), but the positive effect of ER on the number of green patent applications is significant from OLS and IV-2SLS models, which verifies Hypothesis 2b.

Table 7. Mechanism analysis of the effects of ER on current FP of polluting firms.

Variable	(1)	(2)	(3)	(4)	(5)
	<i>Ope_Cost</i>	<i>lnROA</i>	<i>Green_Patent</i>	<i>lnROA</i>	<i>lnROA</i>
<i>En_Re</i>	0.762 (1.00)	−0.006 (−1.63)	0.493 *** (2.64)	−0.890 ** (−2.04)	0.068 * (1.94)
<i>Ope_Cost/Green_Patent</i>		−0.004 *** (−16.01)		−0.001 * (−1.75)	−0.001 * (−1.83)
Control variables	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Constant	93.524 *** (3.71)	5.302 *** (53.45)	2.683 (0.64)	4.977 *** (41.37)	4.635 *** (20.87)
R ²	0.051	0.470	0.021	0.207	0.564
F	5.957	47.236	2.481	18.264	14.312
Observations	2527	2527	2527	2527	2527

This table shows the mechanism analysis of the effects of ER on the current FP of polluting firms. In order to avoid the problem of reverse causality between firm-level control variables and FP, all firm-level control variables in this paper are at a one-period lag. Control variables are the same as those in Table 3. The mediating variable in columns (1)–(2) is *Ope_Cost*, while the mediating variable in column (3)–(5) is *Green_Patent*. The last column reports the IV-2SLS results. The F-value 14.312 of the first-stage regression indicates that there is no weak IV problem. The t-values in columns (1)–(4) and the Z-values in column (5) are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

Specifically, results from Table 8 show that ER significantly increases the number of green invention and utility patent applications of polluting firms in the current period. The

Table 9. Cont.

Variable	OLS		IV–2SLS					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>TAT</i>	<i>lnROE</i>	<i>Ope_Cost</i>	<i>lnROE</i>	<i>TAT</i>	<i>lnROE</i>	<i>Ope_Cost</i>	<i>lnROE</i>
Constant	2.677 *** (3.13)	4.872 *** (11.34)	148.626 *** (4.61)	6.305 *** (13.05)	0.465 (0.41)	4.135 *** (6.31)	149.866 *** (4.20)	5.233 *** (8.41)
R ²	0.270	0.123	0.094	0.272	0.162	−0.028	−0.005	0.138
F	16.310	7.972	5.410	10.808	43.64	13.38	7.15	34.45
Observations	1805	1805	1805	1805	2166	2166	2166	2166

This table shows the mechanism analysis of the lagged effect of ER on the FP of polluting firms. In order to avoid the problem of reverse causality between firm-level control variables and FP, all firm-level control variables in this paper are at a one-period lag. The independent variable is *L3.ER* in columns (1)–(4) and estimated by OLS models and in columns (5)–(8), the independent variable is *L2.ER* and the results are estimated by IV-2SLS models. *L2.ER* and *L3.ER* indicate the environmental regulations with a lag of two periods and three periods, respectively. Control variables are the same as those in Table 3. The mediating variables in columns 2 and 6 are the *TAT*, and the mediating variables in columns 4 and 8 are the *Ope_Cost*. Referring to Sribney et al. (Available online: <https://www.stata.com/support/faqs/statistics/two-stage-least-squares/> accessed on 14 February 2022), it is likely for R² to be a negative value in IV-2SLS when RSS > TSS, and it make no difference on the estimation quality. The t-values in columns (1)–(4) and the Z-values in columns (5)–(8) are in parentheses, and * and *** represent significance levels at 10% and 1%, respectively.

6. Further Discussion

6.1. Effect of ER on FP of Mildly Polluting Firms

We also obtained data on 936 mildly polluting A-shares firms to analyze the effect of ER on their FP and compare it with heavy polluters. The results in Table 10 show that the effect of ER on FP of mildly polluting firms is not significant either for the current period or one to three periods later.

Table 10. Effect of ER on FP of mildly polluting firms.

Variable	OLS		IV–2SLS	
	(1)	(2)	(3)	(4)
	<i>lnROE</i>	<i>lnROE</i>	<i>lnROE</i>	<i>lnROE</i>
<i>ER</i>	−0.010 (−1.03)		0.538 (0.77)	
<i>L2.ER</i>				0.122 (1.39)
<i>L3.ER</i>		0.016 * (1.82)		
Control variable	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Constant	5.298 *** (39.81)	4.93 *** (23.40)	5.121 *** (20.21)	4.940 ** (35.88)
R ²	0.294	0.059	0.004	0.017
F	65.960	9.392	2.51	4.78
Observations	6552	4680	6552	5616

This table shows the effect of ER on FP of mildly polluting firms. In order to avoid the problem of reverse causality between firm-level control variables and FP, all firm-level control variables in this paper are at a one-period lag. Control variables are the same as those in Table 3. *L2.ER* and *L3.ER* indicate the environmental regulations with a lag of two periods and three periods, respectively. The results in columns (1)–(2) are estimated by OLS models and t-values are in parentheses. In addition, the results in columns (3)–(4) are estimated by IV-2SLS models and the Z-values are in parentheses. *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

6.2. The Effect of ER on FP of Highly Polluting Firms by Ownership

We grouped the highly polluting firms by their ownership into state-owned and private to make a heterogeneous analysis. The results from Table 11 show that ER mainly affects state-owned firms, while it has a limited effect on private firms. This is likely because

state-owned firms have a greater responsibility to be ‘leaders’ in implementing government policy and they can bear more financial risks associated with green innovation. Therefore, the negative effect of ER on current FP (column 1) and the positive effect on the future FP (column 4) of state-owned firms are significant. The last two columns verify that the ER with a three-period lag increases the total asset turnover rate, thus improving the FP of state-owned firms. The results are basically in line with those of Xu et al. [42].

Table 11. Effect of ER on the FP of polluting firms by ownership type.

Variable	State-Owned	Privately-Owned	State-Owned	Privately-Owned	State-Owned	State-Owned
	ROE	ROE	ROE	ROE	TAT	ROE
	(1)	(2)	(3)	(4)	(5)	(6)
ER	−3.104 ** (−2.23)	0.474 (0.47)				
L3.ER			3.678 ** (2.40)	0.607 (0.73)	0.049 ** (2.07)	3.005 * (1.92)
TAT						13.826 *** (3.93)
Control variable	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Constant	111.755 * (1.83)	67.724 ** (2.36)	225.659 ** (2.00)	16.871 (0.37)	2.655 (1.43)	188.950 (1.62)
R ²	0.144	0.247	0.107	0.071	0.311	0.136
F	7.794	11.592	4.085	2.698	7.831	4.669

This table shows the heterogeneous effect of ER on the FP of polluting firms. In order to avoid the problem of reverse causality between firm-level control variables and FP, all firm-level control variables in this paper are at a one-period lag. Control variables are the same as those in Table 3. L3.ER indicate the environmental regulations with a lag of three periods. The results in columns (1), (3), and (5) are for state-owned firms and the results in columns (2), (4), and (6) are for privately-owned firms. The t-values are in parentheses and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

6.3. The Effect of ER on Expected FP of Highly Polluting Firms

There are differences in the effect of ER on actual profitability and expected profitability [11]. Therefore, we use Tobin’s Q to characterize expected FP and explore the effect of ER on expected FP of highly polluting firms. Table 12 shows that ER has a significant negative effect on the expected FP of highly polluting firms in the current period (column 1) and one period later (column 2), while the effect on expected FP two or three periods later is nonsignificant (column 3 and 4). In addition, the results still hold when Tobin’s Q is logarithmized ($\ln \text{Tobin's } Q = \ln(\text{Tobin's } Q + 100)$) (column 5 and 6). Our results are consistent with the conclusions of Rassier and Earnhart [11].

Table 12. Effect of ER on Tobin’s Q of highly polluting firms.

Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Tobin’s Q	Tobin’s Q	Tobin’s Q	Tobin’s Q	$\ln \text{Tobin's } Q$	$\ln \text{Tobin's } Q$
ER	−0.178 * (−1.93)				−0.054 ** (−2.40)	
L1.ER		−0.142 (−1.49)				−0.041 * (−1.76)
L2.ER			−0.077 (−0.94)			
L3.ER				0.028 (0.50)		

Table 12. Cont.

Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)
	<i>Tobin's Q</i>	<i>Tobin's Q</i>	<i>Tobin's Q</i>	<i>Tobin's Q</i>	<i>lnTobin's Q</i>	<i>lnTobin's Q</i>
Control variable	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Constant	10.905 ** (2.46)	11.511 ** (2.52)	14.034 *** (2.92)	17.398 *** (2.97)	3.124 *** (3.07)	3.295 *** (3.15)
R ²	0.343	0.343	0.330	0.277	0.412	0.411
F	18.760	18.500	17.613	15.031	27.865	27.464
Observations	1590	1590	1272	954	1590	1590

This table shows the effect of ER on Tobin's Q of highly polluting firms. In order to avoid the problem of reverse causality between firm-level control variables and FP, all firm-level control variables in this paper are at a one-period lag. Control variables are the same as those in Table 3. *L1.ER*, *L2.ER*, and *L3.ER* indicate the environmental regulations with a lag of one period, two periods, and three periods, respectively. The dependent variable in columns (1)–(4) is Tobin's Q, while the dependent variable in columns (5) and (6) is logarithmic Tobin's Q. The t-values are in parentheses and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

In the further discussion, we confirm that the effect of ER on the FP of mildly polluting firms is not significant. In addition, ER mainly affects state-owned firms, while it has a limited effect on private firms due to the greater responsibility for state-owned firms. Furthermore, ER has a significant negative effect on expected profitability in the current period and one period later, because the ER will exert a negative and short-run effect on the market value.

7. Conclusions

This paper explores the effect of ER on the FP of polluting firms, on which there is no consensus among scholars. We conduct an empirical analysis of the current and lagged effects of ER on FP, which verifies the negative effect of ER on FP in the current period and the lagged positive effect on FP, which unifies CRH and PH on the temporal dimension. The main findings of this paper are as follows.

First, ER significantly reduces the FP of polluting firms in the current period, and one of the channels is to increase their green innovation investment. Second, ER compels polluting firms to improve their operating efficiency by changing their production and operation methods, which has a significant positive effect on their FP, but there is a certain lagged effect. The above two conclusions unify CRH and PH, which are mixed in the existing research. Third, ER mainly affects the FP of highly polluting firms and state-owned firms, but neither mildly polluting firms nor private firms, and this result indicates that the ER should be targeted. In addition, we test the conclusions from Rassier and Earnhart [11] that there is a negative effect of ER on expected FP using the data from China.

The conclusions show the 'short pain' and 'long gain' effect of ER on the FP of highly polluting firms and provide implications for governments and highly polluting firms. For government, more green innovation subsidies should be provided for firms to promote their green transformation. For highly polluting firms, they should change their development concepts to realize green and sustainable development. From the theoretical point, this paper illustrates the different impacts of ER on the FP of polluting firms on the temporal dimension and explores the influencing mechanism, implying the potential effects of green innovation investment and operating efficiency.

Future research can compare the different impacts of command-to-control and market-based environmental regulations on current as well as future FP of polluting firms. Furthermore, the research can be extended to other emerging markets and developed countries.

Author Contributions: Conceptualization, J.D. and X.L. (Xiuting Li); methodology, X.L. (Xiaoting Liu); software, X.L. (Xiaoting Liu) and K.J.; validation, X.L. (Xiaoting Liu) and K.J.; formal analysis, X.L. (Xiaoting Liu); investigation, X.L. (Xiaoting Liu) and X.L. (Xiuting Li); resources, X.L. (Xiuting

Li) and S.X.; data curation, X.L. (Xiaoting Liu) and K.J.; writing—original draft preparation, X.L. (Xiaoting Liu); writing—review and editing, X.L. (Xiuting Li) and S.X.; visualization, K.J.; supervision, J.D.; project administration, J.D. and X.L. (Xiuting Li); funding acquisition, J.D. and X.L. (Xiuting Li). All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by National Natural Science Foundation of China, grant number Project No. 71850014, 71974180, 71532013.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data used and analysed during this study are available from the corresponding author by request.

Acknowledgments: We appreciate comments we received from Jia Liu and Hongbo Duan.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Aşıcı, A.A.; Acar, S. How does environmental regulation affect production location of non-carbon ecological footprint? *J. Clean. Prod.* **2018**, *178*, 927–936. [CrossRef]
2. List, J.A.; Millimet, D.L.; Fredriksson, P.G.; McHone, W.W. Effects of Environmental Regulations on Manufacturing Plant Births: Evidence from a Propensity Score Matching Estimator. *Rev. Econ. Stat.* **2003**, *85*, 944–952. [CrossRef]
3. Palmer, K.; Oates, W.E.; Portney, P.R. Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm? *J. Econ. Perspect.* **1995**, *9*, 119–132. [CrossRef]
4. Gray, W.B.; Shadbegian, R.J. Plant vintage, technology, and environmental regulation. *J. Environ. Econ. Manag.* **2003**, *46*, 384–402. [CrossRef]
5. Xie, R.-H.; Yuan, Y.-J.; Huang, J.-J. Different Types of Environmental Regulations and Heterogeneous Influence on “Green” Productivity: Evidence from China. *Ecol. Econ.* **2017**, *132*, 104–112. [CrossRef]
6. Fu, T.; Jian, Z. Corruption pays off: How environmental regulations promote corporate innovation in a developing country. *Ecol. Econ.* **2021**, *183*, 106969. [CrossRef]
7. Porter, M.E. America’s Green Strategy. *Sci. Am.* **1991**, *264*, 168. [CrossRef]
8. Porter, M.E.; van der Linde, C. Toward a new conception of the environment-competitiveness relationship. *J. Econ. Perspect.* **1995**, *9*, 97–118. [CrossRef]
9. Berman, E.; Bui, L.T.M. Environmental Regulation and Productivity: Evidence from Oil Refineries. *Rev. Econ. Stat.* **2001**, *83*, 498–510. [CrossRef]
10. Ambec, S.; Barla, P. A theoretical foundation of the Porter hypothesis. *Econ. Lett.* **2002**, *75*, 355–360. [CrossRef]
11. Jefferson, G.H.; Tanaka, S.; Yin, W. Environmental Regulation and Industrial Performance: Evidence from Unexpected Externalities in China. 1 February 2013. Available online: <https://ssrn.com/abstract=2216220> (accessed on 14 February 2022).
12. Rassier, D.G.; Earnhart, D. Effects of environmental regulation on actual and expected profitability. *Ecol. Econ.* **2015**, *112*, 129–140. [CrossRef]
13. Huang, Z.; Zhang, H.; Duan, H. Nonlinear globalization threshold effect of energy intensity convergence in Belt and Road countries. *J. Clean. Prod.* **2019**, *237*, 117750. [CrossRef]
14. Li, H.; Li, B. The threshold effect of environmental regulation on the green transition of the industrial economy in China. *Econ. Res.-Ekon. Istraž.* **2019**, *32*, 3134–3149. [CrossRef]
15. Tang, H.-L.; Liu, J.-M.; Wu, J.-G. The impact of command-and-control environmental regulation on enterprise total factor productivity: A quasi-natural experiment based on China’s “Two Control Zone” policy. *J. Clean. Prod.* **2020**, *254*, 120011. [CrossRef]
16. Jaffe, A.B.; Peterson, S.R.; Portney, P.R.; Stavins, R.N. Environmental regulation and the competitiveness of US manufacturing: What does the evidence tell us? *J. Econ. Lit.* **1995**, *33*, 132–163.
17. Jaffe, A.B.; Palmer, K. Environmental Regulation and Innovation: A Panel Data Study. *Rev. Econ. Stat.* **1997**, *79*, 610–619. [CrossRef]
18. Wagner, M.; Nguyen-Van, P.; Azomahou, T.; Wehrmeyer, W. The relationship between the environmental and economic performance of firms: An empirical analysis of the European paper industry. *Corp. Soc. Responsib. Environ. Manag.* **2002**, *9*, 133–146. [CrossRef]
19. Rassier, D.G.; Earnhart, D. The Effect of Clean Water Regulation on Profitability: Testing the Porter Hypothesis. *Land Econ.* **2010**, *86*, 329–344. [CrossRef]
20. Lanoie, P.; Laurent-Lucchetti, J.; Johnstone, N.; Ambec, S. Environmental Policy, Innovation and Performance: New Insights on the Porter Hypothesis. *J. Econ. Manag. Strat.* **2011**, *20*, 803–842. [CrossRef]
21. Hart, S.L.; Ahuja, G. Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. *Bus. Strateg. Environ.* **1996**, *5*, 30–37. [CrossRef]

22. Cordeiro, J.J.; Sarkis, J. Environmental proactivism and firm performance: Evidence from security analyst earnings forecasts. *Bus. Strateg. Environ.* **1997**, *6*, 104–114. [[CrossRef](#)]
23. Lanoie, P.; Patry, M.; Lajeunesse, R. Environmental regulation and productivity: Testing the porter hypothesis. *J. Product. Anal.* **2008**, *30*, 121–128. [[CrossRef](#)]
24. Chen, Y.; Ma, Y. Does green investment improve energy firm performance? *Energy Policy* **2021**, *153*, 112252. [[CrossRef](#)]
25. Rassier, D.G.; Earnhart, D. Short-Run and Long-Run Implications of Environmental Regulation on Financial Performance. *Contemp. Econ. Policy* **2010**, *29*, 357–373. [[CrossRef](#)]
26. Wu, W.; Liu, Y.; Wu, C.; Tsai, S. An empirical study on government direct environmental regulation and heterogeneous innovation investment. *J. Clean. Prod.* **2020**, *254*, 120079. [[CrossRef](#)]
27. Liu, C.; Fang, J.; Xie, R. Energy policy and corporate financial performance: Evidence from China's 11th five-year plan. *Energy Econ.* **2021**, *93*, 105030. [[CrossRef](#)]
28. Zhao, X.; Zhao, Y.; Zeng, S.; Zhang, S. Corporate behavior and competitiveness: Effect of environmental regulation on Chinese firms. *J. Clean. Prod.* **2015**, *86*, 311–322. [[CrossRef](#)]
29. Hering, L.; Poncet, S. Environmental policy and exports: Evidence from Chinese cities. *J. Environ. Econ. Manag.* **2014**, *68*, 296–318. [[CrossRef](#)]
30. Hu, J.; Huang, Q.; Chen, X. Environmental regulation, innovation quality and firms' competitiveness—Quasi-natural experiment based on China's carbon emissions trading pilot. *Econ. Res.-Ekon. Istraž.* **2020**, *33*, 3307–3333. [[CrossRef](#)]
31. Xing, X.; Liu, T.; Shen, L.; Wang, J. Linking Environmental Regulation and Financial Performance: The Mediating Role of Green Dynamic Capability and Sustainable Innovation. *Sustainability* **2020**, *12*, 1007. [[CrossRef](#)]
32. Zhang, G.; Liu, W.; Duan, H. Environmental regulation policies, local government enforcement and pollution-intensive industry transfer in China. *Comput. Ind. Eng.* **2020**, *148*, 106748. [[CrossRef](#)]
33. Zhang, M.; Sun, X.; Wang, W. Study on the effect of environmental regulations and industrial structure on haze pollution in China from the dual perspective of independence and linkage. *J. Clean. Prod.* **2020**, *256*, 120748. [[CrossRef](#)]
34. Levinson, A. Environmental regulations and manufacturers' location choices: Evidence from the Census of Manufactures. *J. Public Econ.* **1996**, *62*, 5–29. [[CrossRef](#)]
35. Wang, X.; Zhang, C.; Zhang, Z. Pollution haven or porter? The impact of environmental regulation on location choices of pollution-intensive firms in China. *J. Environ. Manag.* **2019**, *248*, 109248. [[CrossRef](#)]
36. Zhang, G.; Zhang, P.; Zhang, Z.G.; Li, J. Impact of environmental regulations on industrial structure upgrading: An empirical study on Beijing-Tianjin-Hebei region in China. *J. Clean. Prod.* **2019**, *238*, 117848. [[CrossRef](#)]
37. Li, M.; Dong, L.; Luan, J.; Wang, P. Do environmental regulations affect investors? Evidence from China's action plan for air pollution prevention. *J. Clean. Prod.* **2020**, *244*, 118817. [[CrossRef](#)]
38. Zhao, X.; Sun, B. The influence of Chinese environmental regulation on corporation innovation and competitiveness. *J. Clean. Prod.* **2016**, *112*, 1528–1536. [[CrossRef](#)]
39. Shen, K.; Jin, G.; Fang, X. Does environmental regulation cause pollution to transfer nearby? *Econ. Res. J.* **2017**, *52*, 44–59. (In Chinese)
40. Liu, K.; Lin, B. Research on influencing factors of environmental pollution in China: A spatial econometric analysis. *J. Clean. Prod.* **2019**, *206*, 356–364. [[CrossRef](#)]
41. Lee, S.; Kim, S.H. A Lag Effect of IT Investment on Firm Performance. *Inf. Resour. Manag. J.* **2006**, *19*, 43–69. [[CrossRef](#)]
42. Xu, F.; Yang, M.; Li, Q.; Yang, X. Long-term economic consequences of corporate environmental responsibility: Evidence from heavily polluting listed companies in China. *Bus. Strat. Environ.* **2020**, *29*, 2251–2264. [[CrossRef](#)]