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How Top-Down Water Regulation Affects the Financial Performance of Enterprises: The River Chief System in China as an Example

Peipei Zhao [1,*], Jiawen Li [2] and Xin Luo [3]

[1] Economics and Management School, Wuhan University, Wuhan 430072, China
[2] Business School, Hohai University, Nanjing 211100, China; 1908020126@hhu.edu.cn
[3] Business School, University of Birmingham, Birmingham B15 2TT, UK; xxl400@student.bham.ac.uk
* Correspondence: peipeizhao@whu.edu.cn

Abstract: As a top-down type of water regulation, the River Chief System (RCS) in China has effectively enhanced urban water quality. Simultaneously, environmental control significantly impacts the financial performance of enterprises. In recent years, the tension between environmental protection and economic development has escalated, underscoring the undeniable economic ramifications of stringent water regulations. Enterprises are the fundamental agents of economic activities and environmental impact, thus becoming the primary targets of water environment regulatory policies. This study adopts the differences-in-differences (DID) method and uses a sample of listed enterprises in the Yangtze River Economic Belt region from 2010 to 2021 to study the impact of the RCS on the financial performance of enterprises. The results show that the RCS harms the financial performance of enterprises. This impact primarily manifests through increased environmental protection investments. Conversely, the RCS does not have a positive influence on enterprises' technological innovation. This indicates the challenge of stringent top-down environmental regulations in stimulating short-term technological advancements and enhancing enterprise performance. Moreover, the adverse effects of the RCS on financial performance are notably pronounced for non-state-owned enterprises and those located in the upper Yangtze River Economic Belt. This suggests that private enterprises and those in less-developed regions exhibit lower resilience to top-down environmental regulations.

Keywords: top-down water regulation; River Chief System; financial performance of enterprises; differences in differences

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1. Introduction

The rapid advancement of urbanization and industrialization has significantly impacted the ecological system, and serious water pollution has resulted in a shortage of available water resources and an imbalance in the ecological environment [1]. As producers, enterprises create value for society, but they also create a series of ecological and environmental problems [2]. Solving the problem of externalities through market mechanisms alone is challenging; thus, governments need to intervene with appropriate macro-environmental regulation policies. For a long time, Chinese environmental policies have been top-down, and decentralized environmental policies tend to be less efficient due to the weak institutional context in developing countries, making it challenging for local governments to fully implement the central government's directives [3].

To effectively mobilize central and local initiatives, China has put the River Chief System (RCS) into practice in recent years. In 2007, the RCS was first piloted in Wuxi City in the Yangtze River Basin, linking river pollution within the jurisdiction to the promotion of government officials' performance [4]. At the end of 2016, China implemented the RCS nationwide. Relevant enterprises promoted the transformation and upgrading of traditional production methods under the government's regulation, which effectively

controlled the pollution of the water environment. The River Chief System exhibits distinct characteristics compared with prior water environmental regulations. River chiefs, serving as local party and government leaders, have multifaceted policy objectives. While environmental governance is crucial, their performance assessments also consider regional economic development. Focusing solely on environmental pollution while disregarding economic growth may constrain their prospects for promotion. Meanwhile, the internal control and management of water resources have mostly been studied from the perspective of enterprises. Consequently, local officials are incentivized to supervise the financial performance of enterprises within their jurisdiction, driven by prospects for political advancement. However, as a government-mandated environmental policy that combines bottom-up and top-down approaches, implementing the RCS has led to an unprecedented intensity of effort in recent years, resulting in excessive water treatment costs.

As one of the most dynamic regions in China, high-quality economic development in the Yangtze River Economic Belt is a key strategy related to China's overall development. However, at present, heavy chemical industrial enterprises along the Yangtze River Economic Belt have resulted in an increasing number of pollution hazards, and the conflict between ecological environmental protection and economic growth in the basin has become increasingly serious. As a region that implemented the RCS earlier, the Yangtze River Economic Belt has significantly improved water pollution control. However, currently, strict environmental regulations may hinder the development of highly polluting and energy-intensive enterprises with higher profit margins, and the manufacturing-based industrial system of the Yangtze River Economic Belt faces numerous challenges in pollution reduction [5]. As the main body of economic activity, the high-quality development of enterprises is one of the important paths to promote the economic level. Therefore, the relationship between environmental policies and the financial performance of enterprises in the Yangtze River Economic Belt should be thoroughly investigated to expand the scope and depth of research on the RCS and provide insights for enhancing top-down policies in developing countries.

2. Literature Review

The existing literature on water regulation policies has focused mainly on early governance models and emission trading systems, with fewer studies addressing microeconomic impacts. Some studies have explored the impact of environmental policies on corporate financial performance, as well as the implementation effects of the RCS. Concerning the former, existing studies have found that the impact of environmental policies on corporate financial performance is dualistic, with both facilitating and inhibiting effects. On the one hand, early studies found that environmental policies increased the costs of corporate pollution control and management, leading to a reduction in short-term profits and a negative impact on financial performance. Meng et al. found that the production cost of enterprises increased after adopting environmental regulations, which reduced the financial performance [6]. Dechezlepretre [7] and Liu [8] pointed out that environmental regulations are not conducive to corporate innovation in the short run, thus having a significant negative impact on corporate financial performance. Deng et al. [9], based on data from China's A-share market, found a negative correlation between the new environmental protection law and the financial performance of high-pollution enterprises. On the other hand, Porter's hypothesis suggests that after implementing environmental policies, enterprise managers will increase the total factor productivity of the enterprise through various methods to offset the loss of costs. This is performed so that, in the long run, environmental policies will promote the technological progress of the enterprises, leading to innovative compensation for production costs and improvements in corporate financial performance. Severo et al. [10] found that implementing environmental policies increases the corresponding costs of enterprises in the short term. However, it stimulates enterprises to engage in technological innovation in the long run, and the short-term costs are offset by the benefits of technological progress, leading to improved corporate financial performance.

Zhao et al. [11] showed that environmental policies are conducive to stimulating innovative behavior in pollution-intensive enterprises. At the same time, R&D investment does not have an immediate impact, and the effect on corporate financial performance gradually manifests after a period of time. Chomachaei et al. [12] found that the stringency of environmental policy had a short-term negative impact but a long-term positive impact on the financial performance of European automobile manufacturers. Bao et al. [13] showed that environmental regulation policies are important factors in promoting corporate financial performance. The main way to improve the efficiency of environmental regulation is to encourage firms to conduct pollution control through technological innovation. The current literature also suggests that the relationship between environmental policies and corporate financial performance may show differentiated results depending on the type of policy, region, time, etc. Regarding the implementation effects of the RCS, existing studies have mainly focused on improving the water environment and regional economic development. Comparing the corresponding water environment management policies in the West with the RCS, some scholars have found from analysis of institutional form that the RCS emphasizes the unified management of decentralized and centralized measures, similar to the European Union's water framework. Regarding implementation results, the RCS and EU water framework have both been shown to improve the quality of water resources [14]. She et al. [15] showed that the RCS significantly reduced the amount of wastewater discharged per unit of GDP and increased the cost of sewage treatment. Zhou et al. [16] found that the RCS not only significantly reduced the negative impacts of animal waste on surface water quality but also effectively mitigated agricultural non-point source pollution based on data from Chinese counties. Li et al. [17] found that the RCS improved water quality in terms of indicators such as pH and ammonia nitrogen, based on weekly monitoring point data.

Considering the samples, variables, indicators, models, and other factors, the existing literature on the impact of environmental policies on corporate financial performance presents different research results. Previous studies on the RCS have primarily analyzed its impact on regional ecological protection, economic growth, and optimization of industrial structures at the macro level, while research at the micro level involving the impact of the River Chief System on corporate financial performance and related mechanisms is relatively lacking. Additionally, less literature has considered the heterogeneous characteristics of listed companies. Therefore, this study introduces corporate technological innovation and environmental protection investment at the micro level to investigate the impact of the RCS on corporate financial performance and its underlying mechanisms. It also analyzes the heterogeneous effects of enterprise ownership and regional factors.

3. Policy and Mechanism Analysis

3.1. Policy Background

The RCS refers to the policy in which local party and government officials at all levels serve as the "river chief" and are responsible for coordinating and organizing the management of the water ecosystem in the area under their jurisdiction. The RCS originated in 2007 in Wuxi, Jiangsu Province. In 2016, the central government issued the "Opinions on the Full Implementation of the River Chief System", and the RCS was elevated to a national policy. In 2018, the RCS was established nationwide. Figure 1 presents the years in which the RCS was implemented in cities of the Yangtze River Economic Belt. This system comprehensively establishes structures at the provincial, municipal, county, and township levels from top to bottom. It accomplishes the tasks of protecting water resources, preventing water pollution, improving the water environment, and repairing the water ecology through the leadership of the party and government to improve the water governance system and promote the construction of ecological civilization.

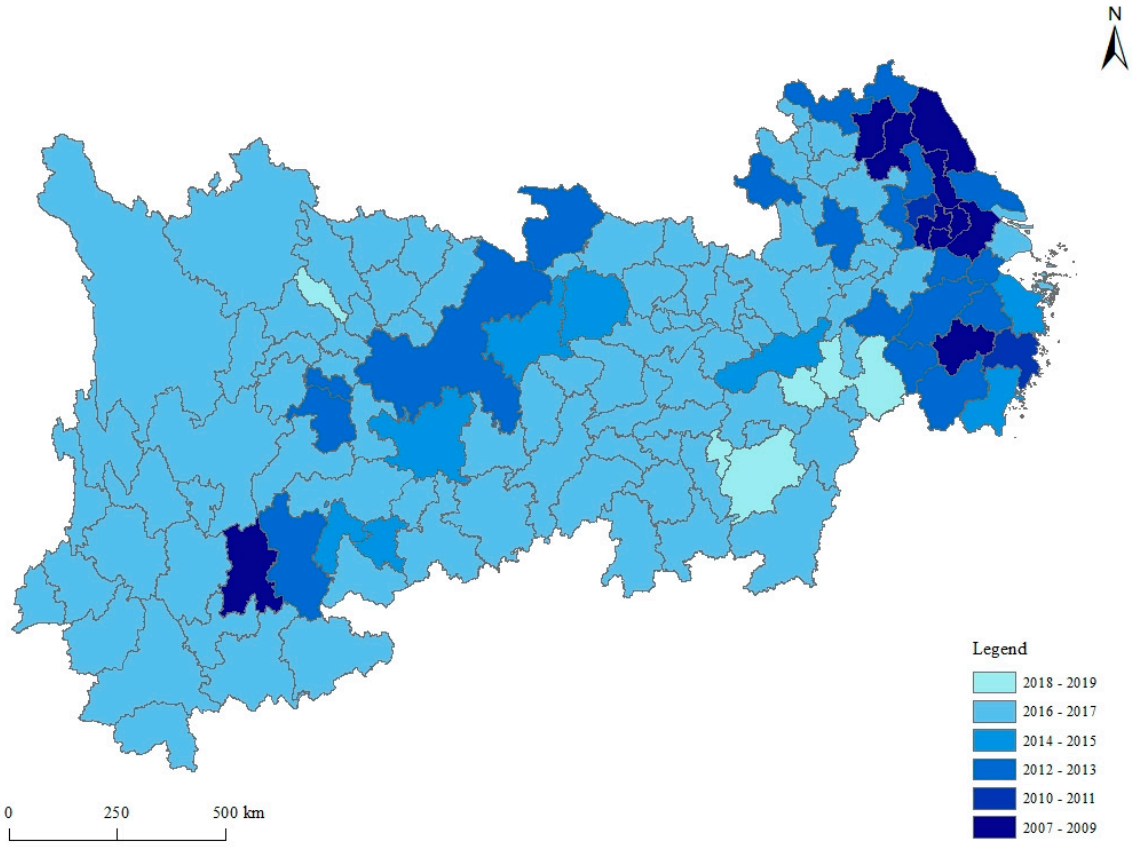

Figure 1. Years of RCS implementation in cities in the Yangtze River Economic Belt.

The RCS is a mandatory environmental policy, which is generally enforced by regulatory means, making it more authoritative and binding than previous water environment policies. To promote sustainable improvement in the water ecological environment, local governments require enterprises to control pollution and achieve clean and efficient production; otherwise, they face penalties such as closure, banning, integration, or relocation. Enterprises' technological innovation often involves long cycles, high investment, and high risks. In the short term, polluting enterprises may be unwilling or find it difficult to promptly innovate through R&D to meet environmental control requirements. Therefore, under the pressure of local government control, enterprises choose processes, equipment, and technologies with high resource utilization efficiency and low pollutant emissions to avoid being penalized for non-compliance. The relative production costs increase and crowd out R&D expenditure, which increases the riskiness and uncertainty of their future investment, hinders the improvement in their productivity and competitiveness, and puts them at a disadvantage in the market.

However, in the long run, measures such as optimizing production factor allocation, promoting green technological innovation, and improving total factor productivity can enhance corporate financial performance, provided they are applied in industries that may impact water quality. Enterprise innovation depends on the level of incentives provided [18]. On the one hand, strengthening water pollution control without reducing production means that enterprises cannot discharge wastewater freely and must introduce or develop clean and green production methods; on the other hand, implementing the RCS increases corporate pollution control and production costs. Enterprises striving for profit maximization exhibit greater willingness and motivation to improve production technologies and reduce costs. Therefore, in the long run, most enterprises can increase profits through R&D and innovation, depending on market conditions and individual circumstances.

3.2. Research Hypotheses

3.2.1. The RCS Affects Corporate Financial Performance through Environmental Protection Investment

Traditional neoclassical economic theory posits that in a perfectly competitive market, where corporate resource allocation operates at static efficiency, environmental policies are expected to adversely affect the financial performance of listed enterprises. Environmental regulations impose prices on ecological resources through governmental macro-control, internalizing external environmental costs. Enterprises, as passive participants in environmental protection issues under governmental control, introduce economic or value constraints to their management structures and production activities. This ultimately internalizes external diseconomies, achieving alignment between the enterprise and the external macro system by adjusting decision-making motives and preferences regarding environmental pollution, resource depletion, and other unethical behaviors. Consequently, this leads to increased costs borne by enterprises for resource utilization and environmental damage, resulting in a significant decline in cash flow over time. Such a decline adversely impacts capital accumulation, reducing enterprise profitability [19]. Concurrently, within the framework of established income, technology, resources, and other conditions, government intervention imposes additional environmental regulatory constraints on corporate production operations and organizational management. Corporate decisions regarding product design, infrastructure, production processes, etc., are constrained by environmental requirements. Consequently, enterprises can only plan production and management within a narrower decision-making scope, undermining effective resource allocation, hindering the enhancement of total factor productivity, and negatively impacting financial performance. Under the pressure of environmental policies, to ensure compliance with environmental governance requirements, enterprises must redirect capital, labor, and other resources from productive activities to pollution prevention. This entails increased investment in sewage technology, production equipment, and other areas to achieve cleaner and greener production. As per the compliance cost effect, environmental policies influence the production strategy choices of enterprises. Consequently, enterprises adjust resource allocation and decrease expenditure on R&D in the business decision-making process, impeding technological progress and reducing operating profits. Thus, the "cost effect" of investment in environmental protection adversely affects the financial performance of listed enterprises following the implementation of the RCS. Given these arguments, our hypothesis states the following:

Hypothesis 1: *The RCS harms corporate financial performance by increasing environmental protection investment.*

3.2.2. The RCS Affects Corporate Financial Performance through Technological Innovation

Porter's hypothesis posits that environmental policies can enhance corporate financial performance. By implementing stringent yet feasible environmental regulations, companies can mitigate the costs associated with environmental compliance, thereby achieving a symbiotic relationship between environmental conservation and economic prosperity. Given the constraints of corporate resources and the imperative of sustainable development, environmental policies can incentivize innovative practices. Enterprises are prompted to expedite their transition toward environmentally sustainable practices, optimize resource allocation, enhance investments in environmentally efficient sectors, improve economic efficiency and research and development (R&D) effectiveness, and reduce production costs through innovation and learning effects [20]. In the short term, enterprises may face market disadvantages due to the increased costs associated with complying with environmental regulations. However, over the long term, the regulatory pressure of the RCS compels most enterprises to redefine their competitive edge through technological research and development (R&D), cleaner production methods, and other innovations. This strategic response allows companies to offset the costs of environmental protection with innovation,

expand their market share, and enhance profitability, thereby bolstering their financial performance [21]. Therefore, our hypothesis is stated as follows:

Hypothesis 2: *The RCS positively impacts corporate financial performance by promoting technological innovation.*

4. Data and Research Design

4.1. Research Design

4.1.1. Method Selection and Model Construction

This study adopted the differences-in-differences method to assess the impact of RCS on corporate financial performance (see Appendix A). The empirical model is as follows:

$$Effi_{it} = \alpha_0 + \alpha_1 Hzz_{it} + \alpha_2 Controls + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where i denotes the industrial enterprise and t denotes time. $Effi_{it}$ denotes the financial performance of i enterprise in the year t. $Hzz_{it} = treat_i \times time_t$ is a 0–1 dummy variable for the implementation time of the RCS. For the prefecture-level city where the enterprise is located and the RCS is implemented, the year after that takes the value 1; otherwise, it is 0. Controls indicate other factors that affect corporate financial performance. μ_i and λ_t are, respectively, the fixed effects of the enterprise and year, and ε_{it} is the residual term.

Based on the analyses above, the RCS may impact corporate financial performance through environmental protection investment, so the impact mechanism model is as follows:

$$M_{\mathrm{it}} = \beta_0 + \beta_1 Hzz_{it} + \beta_2 Controls + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

$$Effi_{it} = \varphi_0 + \varphi_1 Hzz_{it} + \varphi_2 M_{\mathrm{it}} + \varphi_3 Controls + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

where M_{it} denotes the mediating variable, β_1 is the estimated coefficient of the core independent variable Hzz_{it} in relation to the mediating variable M_{it}, and φ_2 is the effect of the mediating variable M_{it} on the dependent variable $Effi_{it}$.

4.1.2. Variable Description

Dependent variable. This study focused on corporate financial performance as the explained variable. Utilizing the Data Envelopment Analysis Banker–Charnes–Cooper model (DEA-BCC) [22], this study comprehensively assessed the operational efficiency of enterprises. Total assets and operating costs served as the input indicators, while total profit and operating income were utilized as the output indicators to gauge financial performance.

Independent variable. This study focused on Hzz_{it} as an explanatory variable. If a prefecture-level city implemented the RCS in a given year, the value is 1; otherwise, the value is 0.

Mediating variables. This study identified environmental protection investment and technological innovation as mediating variables. According to research by Zhang et al. [23], environmental protection investment is characterized by expenditure directly associated with environmental initiatives within the construction-in-progress accounts of enterprises. Additionally, environmental investment data were standardized using year-end total assets to mitigate the impact of variations in enterprise size. According to research by Tan et al. [24], this study used the number of independently filed invention patents to denote the technological innovation of enterprises, by adding 1 to it and then taking the natural logarithm.

Control variables. Referring to previous studies, this study selected the regional economic development level, degree of openness to the outside world, company size, capital structure, equity structure, and sales profit margin as control variables. These variables were included to account for potential confounding factors and enhance the robustness of the analysis.

Table 1 summarizes all the variables examined in this study.

Table 1. The definition of variables.

Variable Type	Variable Symbol	Variable Meaning	Variable Description
Dependent variables	*Effi*	Financial performance of enterprises	DEA–BCC
Independent variables	*Hzz*	Dummy variable	Equals 1 to indicate the year after the implementation of the RCS; otherwise, it indicates that the RCS has not been implemented.
Control variables	*lnGDP*	Regional economic development level	Ln (GDP)
	trade	Degree of openness	Total exports and imports/GDP
	lnScale	Company size	Ln (total assets)
	lev	Capital structure	Debt-to-asset ratio
	SH	Equity structure	Shareholding ratio of the largest shareholder
	pro	Sales profit margin	Operating profit/total operating revenue
Mediating variables	*inv*	Environmental protection investment	Environmental protection investment/total assets
	inn	Technological innovation	Ln (total number of patent applications for inventions filed independently in the year, plus 1)

4.2. Data Description

In this study, listed enterprises in the Yangtze River Economic Belt region from 2010 to 2021 were selected as the research objects, and the following types of enterprises were excluded:

- *Special treatment (*ST) and special treatment (ST) enterprises with abnormal financial conditions during the study period;
- Enterprises in the financial industry with a special business nature and statement information;
- Enterprises with serious missing data.

The data for the RCS were collected manually, mainly by searching the websites of each prefecture-level municipal government and the relevant documents released on the PKULAW website; the regional economic data were obtained from the *China Urban Statistical Yearbook*; the data on environmental protection investment were obtained from the notes of corporate annual financial reports; the patent data were obtained from the CNRDS database; and the other data were obtained from the CSMAR database.

5. Results

5.1. Basic Results

Column (1) of Table 2 presents the regression results indicating the impact of the RCS on corporate financial performance. The coefficient of *Hzz* is significantly negative at 1%, suggesting that the RCS does not contribute positively to financial performance. In an economic sense, the implementation of RCS has decreased corporate financial performance by 1%, which aligns with H1's expectations. This can be attributed to the government's imposition of environmental protection requirements under the RCS, necessitating substantial investments in pollution control by enterprises to optimize the water ecological environment in a sustainable way. Consequently, these investments have increased production and operational costs, reducing corporate profitability. Moreover, they divert resources from productive activities, leading to adjustments in resource allocation and decreased spending on technological innovation. Ultimately, this scenario hampers corporate factor productivity enhancement.

Table 2. The basic regression and robustness test results.

Variable	*Effi*	*Effi*	*Effi*
Hzz	−0.010 * (−1.830)		−0.010 * (−1.860)
Hzz^{-1}		−0.008 (−1.390)	
Controls	YES	YES	YES
Constant	1.564 *** (8.490)	1.557 *** (8.430)	1.486 *** (7.620)
Time and Individual Fixed effects	YES	YES	YES
N	4675	4675	4250
R-squared	0.112	0.111	0.084

Note: *** and * indicate 1% and 10% significance levels. *p*-value in parentheses.

5.2. Robustness Tests

5.2.1. Counterfactual Test

Referring to a study by Fan et al. [25], we conducted a robustness test by adjusting the implementation timeline of the RCS. Specifically, we assumed that the RCS took effect one year earlier in the prefecture-level city where the processing group was located and set up a fictitious policy interaction term Hzz^{-1}. A significant regression coefficient for this term on enterprise financial performance would suggest that factors beyond the RCS implementation have driven changes in financial performance in the region. However, the results in column (2) of Table 2 indicate that the coefficient for the policy interaction term was not significant, implying that changes in financial performance following RCS implementation were not influenced by extraneous factors.

5.2.2. Control Variables Lagged by One Period

According to a study by Sun et al. [26], to mitigate potential endogeneity issues, we lagged all control variables by one period for regression analysis. The results, presented in column (3) of Table 2, reveal a significantly negative coefficient of *Hzz* at 5%, aligning with the original regression results.

5.3. Parallel Trend Test

The premise of using the differences-in-differences method is to test the parallel trend hypothesis. This study designated the year of RCS implementation as the base period, excluded it, and established dummy variables for the 3 years preceding and 3 years succeeding the policy enactment. Dummy variables *Hzz_3* and *Hzz_2* were set to 1 for the initial 3 years and 2 years, respectively, prior to RCS implementation. Similarly, *Hzz1*, *Hzz2*, and *Hzz3* were set to 1 for the final 1 year, 2 years, and 3 years after RCS implementation, while all other years were assigned a value of 0. Table 3 shows that the impact coefficients prior to RCS implementation were statistically insignificant, consistent with the expectations of the parallel trend hypothesis. Subsequently, the impact coefficient exhibited significant negativity in the second period after the RCS came into effect, indicating that the RCS did not foster enhancements in corporate financial performance and that the impact of the RCS on corporate financial performance included a lag. After some time, the RCS caused a "cost effect" on enterprise production activities, exerting substantial short-term adverse effects on financial performance. Enterprises were compelled to heighten environmental regulatory constraints within their core production and operational domains, undermining the rational allocation of labor, capital, and other resources and encumbering productive activities. With time, the operational dynamics of the RCS tended to stabilize, and the impact on the production costs of enterprises levelled off.

Table 3. The results of the parallel trend.

Variable	*Effi*
Hzz_3	0.003 (0.250)
Hzz_2	0.001 (0.250)
Hzz0	−0.007 (−1.220)
Hzz1	−0.008 (−1.070)
Hzz2	−0.016 * (−1.690)
Hzz3	−0.012 (−1.240)
Controls	YES
Year fixed effect	YES
Enterprise fixed effect	YES
N	4675
R-squared	0.112

Note: * indicate 10% significance levels. *p*-value in parentheses.

6. Discussion

6.1. Mechanism Analysis

To further investigate the crowding-out effect on corporate financial performance caused by investments in environmental protection and to elucidate the mechanisms through which environmental policies influence corporate financial outcomes, this study utilized environmental protection investment and technological innovation as mediating variables. The test results are presented in Table 4. The results reveal a significantly positive coefficient of *Hzz* on *inv*. In contrast, the impact coefficient of *inv* on *Effi* is significantly negative, suggesting that the environmental protection investment has a fully mediating effect between the RCS and corporate financial performance, and H2 is confirmed. Compliance with the RCS compels enterprises to allocate capital and human resources toward environmental management, thereby diverting resources from productive activities. This diversion may impede research and development innovation within these enterprises, consequently exerting a negative influence on their financial performance. The results of *inn* reveal an insignificant coefficient of the RCS on corporate technological innovation, suggesting that compliance with the RCS does not foster technological innovation within enterprises or enhance financial performance. This lack of significance may stem from the protracted timeframe required for technological innovation to materialize, juxtaposed with the relatively short duration of RCS implementation, thus impeding its ability to stimulate technological innovation and subsequently improve financial performance within enterprises.

Table 4. Mechanism test results.

Variable	*inv*	*Effi*	*inn*
Hzz	0.011 ** (2.010)	0.001 (0.060)	0.072 (0.730)
Inv		−0.189 ** (−2.110)	
Controls	YES	YES	YES
Constant	0.077 (0.540)	0.254 (0.860)	7.689 *** (2.94)
Year fixed effect	YES	YES	YES
Enterprise fixed effect	YES	YES	YES
N	605	605	605
R-squared	0.087	0.306	0.070

Note: *** and ** indicate 1% and 5% significance levels. *p*-value in parentheses.

6.2. Heterogeneity Analysis

Does the RCS have varying effects on the financial performance of enterprises because of the differences in the industries and regions to which the enterprises belong? To answer this question, this study examined the heterogeneity of the RCS's impact on corporate financial performance by considering differences in enterprise ownership and regions.

6.2.1. Enterprise Ownership Differences

Considering the variations in enterprise ownership, this study divided the sample into state-owned and non-state-owned enterprises, and the results are shown in Table 5. The coefficient of *Hzz* on the financial performance of state-owned enterprises was insignificant. Still, the coefficient of *Hzz* on the financial performance of non-state-owned enterprises (−0.016) was significantly negative at 5%. Thus, *Hzz* has a significantly negative impact on the financial performance of non-state-owned enterprises. This can be attributed to several factors. Firstly, regarding resource endowment, state-owned enterprises are more likely to receive financial support and policy favors from the government when facing capital shortage, representing a great advantage in terms of financial support and financing capacity. As a result, they are more affordable to additional production costs and have a stronger ability to conduct green technological innovation [27]. Therefore, state-owned enterprises demonstrate lower sensitivity to the environmental cost pressure imposed by the RCS. In contrast, non-state-owned enterprises prioritize profit maximization and value creation; they are more difficult to finance in the face of environmental governance, representing a type of investment characterized by a long time frame and uncertain returns. Secondly, regarding market sensitivity, state-owned enterprises, with government agencies as their actual controllers, tend to follow the environmental regulatory policies more closely and are less responsive to changes in the external market environment and information transfer. Most non-state-owned enterprises are more technologically backward and more sensitive to market information, and they have a decentralized operation mechanism. Due to pressure from the RCS and other national environmental regulatory policies, they encounter higher environmental uncertainty and financial risks, rendering their internal management and production activities more susceptible to shocks arising from increased production costs.

Table 5. Heterogeneity analysis regression results.

Variable	State-Owned	Non-State	*Effi* Upstream Regions	Midstream Regions	Downstream Regions
Hzz	−0.004	−0.016 **	−0.037 ***	0.000	−0.007
	(−0.560)	(−2.200)	(−2.630)	(−0.010)	(−0.970)
Controls	YES	YES	YES	YES	YES
Constant	1.347 ***	1.663 ***	−0.677	0.892 *	1.751 ***
	(5.060)	(6.500)	(−1.060)	(1.710)	(7.540)
Year fixed effect	YES	YES	YES	YES	YES
Enterprise fixed effect	YES	YES	YES	YES	YES
N	2244	2431	817	903	2955
R-squared	0.119	0.122	0.229	0.098	0.110

Note: ***, **, and * indicate 1%, 5%, and 10% significance levels. *p* Value in parentheses.

6.2.2. Regional Differences

The Yangtze River Economic Belt encompasses three major economic regions in Eastern, Central, and Western China. The 11 provinces and cities along the river exhibit significant disparities in economic foundations, resource endowments, and industrial development. Therefore, it is essential to investigate the regional heterogeneity of the RCS's impact on corporate financial performance to tailor policy implementation to local conditions. This study conducted a heterogeneity test based on the provinces and cities of the

Yangtze River Economic Belt, dividing them into upstream, midstream, and downstream regions. The results are presented in Table 5. For enterprises in the upstream region, *Hzz* was found to have a 3.7% inhibition effect (significant at 10%). However, the coefficient of *Hzz* on the financial performance of enterprises in the midstream and downstream regions showed no significant correlation. This suggests that the RCS has negatively impacted the financial performance of enterprises in the upstream region but has not significantly affected enterprises in the midstream and downstream regions. This difference may be attributed to the relatively lower level of economic development and environmental management in the upstream region compared with the downstream and midstream regions. After implementing the RCS, enterprises in the upstream region must allocate additional resources to meet government regulations regarding environmental protection, leading to increased financial strain. This, in turn, negatively impacts their financial performance. Conversely, the downstream and midstream regions have undertaken measures to adjust and optimize their industrial structures, including establishing policies such as ecological civilization demonstration zones and integrated development demonstration zones. As a result, the level of environmental pollution is lower in these regions, leading to less discernible impacts of the RCS on the financial performance of enterprises.

7. Conclusions

Based on the financial data of listed enterprises in the Yangtze River Economic Belt from 2010 to 2021, this study empirically examined the impact and mechanism of the RCS on corporate financial performance, using a difference-in-differences model. This study found that the RCS increases corporate investment in environmental protection, prompting enterprises to allocate capital, labor, and other resources from productive activities toward environmental governance, which, in turn, hinders the technological progress of enterprises and harms their financial performance. The short-term nature of this effect confirms the applicability of the compliance cost hypothesis to the RCS. Conversely, the RCS does not have a positive impact on corporate technological innovation. This suggests that strict top-down environmental policies may not immediately foster technological progress or enhance corporate financial performance. Porter's hypothesis does not hold true for the RCS during the study period. Further differentiating the sample showed that the economic impact of the RCS is affected by differences in enterprise ownership and the regions where they are located. Particularly, non-state-owned enterprises and those located upstream in the Yangtze River Economic Belt experience a more pronounced negative impact from the RCS on their financial performance. This suggests that private enterprises and enterprises in less developed regions are less resilient to top-down environmental policies.

The study results suggest the following practical implications.

First, the government should strengthen cooperation with enterprises and guide enterprises to emphasize green technology innovation. Environmental regulation and corporate development are not mutually exclusive. The government should give full consideration to the affordability of enterprises when making decisions and provide appropriate subsidies to start-up and growing enterprises to compensate for the losses of enterprises that are more negatively affected by the policy. At the same time, incentives such as subsidies and tax breaks should be provided to enterprises that meet the requirements of environmental protection standards through green technological innovation in order to guide them to increase research and development efforts and continuously innovate production technologies to improve resource utilization efficiency [28].

Second, the government should establish a long-term mechanism for optimizing the business environment and use market-based means to regulate flexibly. The impact of the RCS varies among enterprises with different property rights. However, the tendency toward a "one-size-fits-all" approach in environmental policy implementation makes it difficult to meet the reasonable demands of different enterprises. Therefore, it is necessary to improve the market mechanism through multiple channels in terms of institutional design, policy guidance, and market operation in order to create a fair, competitive environment

for non-state-owned enterprises and protect their legitimate rights and interests. At the same time, cooperation between state-owned and non-state-owned enterprises should be promoted to achieve the diffusion of environmental technology innovation within the same industry [29].

Third, the government should implement environmental policies according to local conditions and strengthen the construction of cross-regional cooperation mechanisms. The impact of the RCS on corporate financial performance in different regions of the Yangtze River Economic Belt has been heterogeneous. The government should give full consideration to the differences in economic development stages between the East and West, strengthen interregional cooperation, promote joint governance models, provide policy support to less developed regions such as the upstream region of the Yangtze River Economic Belt, and strive for a win–win scenario for both the environment and economy [30].

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Appendix A. Differences-in-Differences Method (DID)

The difference-in-differences (DID) approach has become one of the most popular research designs used to evaluate the causal effects of policy interventions. In its canonical format, there are two time periods and two groups; in the first period, no one is treated, and in the second period, some units are treated (the treated group) and some units are not (the comparison group). If, in the absence of treatment, the average outcomes for the treated and comparison groups have followed parallel paths over time (which is the so-called parallel trends assumption), one can estimate the average treatment effect for the treated subpopulation by comparing the average change in outcomes experienced by the treated group to that experienced by the comparison group.

Let $Y(i, t)$ be the outcome of interest for individual i at time t. The population is observed in a pre-treatment period $t = 0$ and a post-treatment period $t = 1$. Between these two periods, some fraction of the population is exposed to the treatment. We denote $D(i, t) = 1$ if the individual i has been exposed to the treatment before the period t, and $D(i, t) = 0$ otherwise. We call those individuals with $D(i, 1) = 1$ treated and those with $D(i, 1) = 0$ controls (or untreated).

The formulation of the DID model is as follows:

$$Y(i,\ t) = \delta(t) + \alpha D(i,\ t)\ + \varepsilon(i) + v(i,\ t) \tag{A1}$$

where $\delta(t)$ is a time-specific component, α represents the impact of the treatment, $\varepsilon(i)$ is an individual-specific component, and $D(i, t)$ is an individual-transitory shock that has a mean of zero at each period with $t = 0, 1$ and is possibly correlated in time.

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