

Research on the Impact of Environmental Regulation on the Financial Performance of Petrochemical Enterprises

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Abstract. China's government environmental protection-related departments attach great importance to the environmental pollution problems of petrochemical enterprises. The Environmental Protection Law as the core ecological regulation policy has been continuously improved to address the impact of macro-environmental regulation on micro-individual petrochemical enterprises. The study subjects are 182 petrochemical companies from 2011-2021. The effect of different environmental regulations on the financial performance of petrochemical companies is studied empirically using a time-fixed effects model and a mediating effects model and using principal component analysis based on an agency cost perspective. The results show that environmental regulations significantly improve petrochemical firms' financial performance and suppress agency costs. Agency costs play a partial mediating role in the process of environmental regulations affecting financial performance.

1 Introduction

While the modernization of socialism with Chinese characteristics has always given prominence to the construction of ecological civilization, and environmental regulation policies have been commonly implemented throughout China, petrochemical companies often appear in reports of environmental pollution incidents. It is necessary to investigate the microeconomic effects of environmental regulation policies on firms as they affect firm behavior and key factors of firm financial performance. Most of the studies on environmental regulation have been built on green innovation performance, and there are research gaps on the agency costs and financial performance of micro-individual petroleum firms. "The Porter hypothesis, which questions the neoclassical view that environmental and economic coordination is a dilemma, argues that moderate environmental regulation and environmental control will lead to "innovation compensation" and promote productivity growth [1]. Since different types of environmental regulations have different degrees of regulation on the production and operation of enterprises, the field of exploring how different types of environmental regulations affect the financial performance of petrochemical enterprises is yet to be explored. However, the Porter hypothesis is based on the overall interest claims of shareholders and managers, while the principal-agent problem is prevalent in real enterprises. Foreign countries, with Kennedy (1994) and Ambic (2006) as the navigators, are the first to turn their perspectives to managerial risk preference factors and corporate governance factors, and few domestic scholars have conducted studies based on the

view of the impact of agency cost issues on corporate finance in principal-agent relationships. In the study of environmental regulation on the internal governance behavior of micro-enterprises, the interests of owners and operators are treated as different individuals with different interests within the same enterprise. With the perfect adjustment of the modernized environmental regulation system in the Chinese style, it is important to shift the perspective to the agency cost issue and study the impact of different types of environmental regulation on the financial performance of enterprises.

Therefore, this paper investigates the impact of environmental regulations on the financial performance of petrochemical enterprises from the perspective of agency costs, verifies the mediating role of agency costs in the impact of environmental regulations on the financial performance of petrochemical enterprises, and proposes suggestions to help petrochemical enterprises improve their financial performance. A possible innovation of the paper is to expand the scope of the research object to study the impact of three different types of environmental regulation policies on the agency cost and financial performance of petrochemical enterprises.

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2 Empirical research design

2.1 Research Assumptions

2.1.1 *Environmental regulations and corporate financial performance*

At the theoretical level, research on the relationship between environmental regulation and corporate financial performance has been categorized by scholars into four mainstream hypotheses, namely, the "traditional hypothesis", the "Porter hypothesis", the "uncertainty hypothesis", and the "New structural Porter hypothesis" [2]. From case studies to theoretical empirical evidence to draw different research conclusions, the impact of environmental regulation on firm performance is summarized in three: significant enhancement, effective inhibition and others.

First, Weiss J (2019) showed that environmental regulation contributes to firm competitiveness and economic efficiency, emphasizing the veracity of the "strong Porter hypothesis" that environmental regulation is positively related to firm performance [3]. Guo Li (2022) verified that the practice of corporate green responsibility by firms would promote corporate performance [4]. Second, there is also a negative effect of environmental regulation on corporate financial performance. The empirical results of Zhao Li (2020) demonstrate that environmental regulations with a one-period lag have a significant inhibitory effect on the performance of pollution-intensive industries, [5]. Finally, there are representative views on the U-shaped impact of environmental regulations on financial performance, Sabah et al. (2014) showed no significant causal relationship between environmental taxes and economic growth [6]. Ma Heng (2022) investigated the relationship between three types of environmental regulations and firm performance from both financial and environmental performance perspectives, and the results showed that command-type environmental regulations have a U-shaped relationship with financial performance, and command-type environmental regulations significantly inhibit environmental investments of non-state enterprises, but market-incentivized and public-participation-type environmental regulations have a significant contribution to firms' environmental investments and financial performance. However, market incentives and public participation environmental regulations have a significant contribution to corporate environmental investment and financial performance [7]. Based on the above analysis, the following hypotheses are formulated:

H1: Environmental regulations have a positive impact on the financial performance

2.1.2 *Environmental regulation and agency costs*

Agency costs are a hindrance to shareholders in wealth maximization. Ni, Jingjie (2020) serious deficiencies in internal control can be equated with the inability of the internal control system to effectively monitor and

resolve agency problems [8]. Li Baixing (2019) found that the time lag effect of environmental regulatory policies can lead to corporate governance mechanisms that only sometimes solve the principal-agent problem [9]. Jinbo Luo (2021) pointed out that uncertainty in the firm's external policies increases agency costs when the firm is classified as a regulated industry by the government [10]. Shi Qingmei (2021) demonstrated that internal control deficiencies in state-owned groups could intensify intra-firm governance problems and conflict of interest due to agency problems. Higher agency costs increasingly lead to short-sighted investment by managers, thus stalling R&D investment and firm performance. In contrast, using a multiple linear regression model, Aimi Zhang (2021) showed that environmental regulation effectively suppresses agency costs in both the East and Midwest regions, with no significant regional differences in the level of suppression. Based on the above analysis, the following hypotheses are formulated:

H2: Environmental Regulation for Inhibiting Agency Costs of Petrochemical Enterprises

2.1.3 *Environmental regulation, agency costs, and corporate financial performance*

Dyck A showed that the more transparent the information disclosure of listed companies in the petrochemical industry, the less effort is required to play information games between management and shareholders, and between major shareholders and minority shareholders, which can alleviate the agency problem and promote the economic growth of the company. Zhao Hong proposed that the "innovation compensation" role of regulation has an impact on industrial performance. Domestic scholars' research mainly focuses on environmental regulation to promote innovation performance. Liu Xuezhi suggests that environmental regulation has a positive impact on the performance of petrochemical industry firms. Li Shu proposed that firms whose agency costs are suppressed by environmental regulation produce an externality effect, and the final result will be reflected in the improvement of firm performance. In summary, environmental regulation inhibits management moral hazard behavior and reduces agency cost's, thus producing a positive governance effect on firm performance. Therefore, the following hypothesis is proposed:

H3: The three types of environmental regulations have a positive effect on a firm financial performance by reducing agency costs

To sum up, the theoretical analysis framework is constructed in Figure 1.

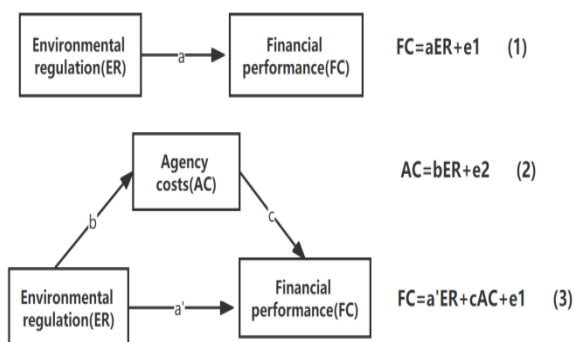


Fig. 1. Theoretical analysis framework.

2.2 Sample selection and variable definition

2.2.1 Sample selection and data sources

In this paper, 182 petrochemical companies are selected from 2011-2021 after excluding incomplete disclosure data and being ST and *ST. Data from CSMAR, China Environmental Statistics Yearbook, etc.

2.2.2 Variable definition

(1) Explanatory variable: the financial performance of enterprises reflects the operating conditions of petrochemical enterprises in a certain period. In recent years, multiple indicators are widely used in the domestic and international empirical analysis literature to comprehensively evaluate the system. Therefore, principal component analysis is used to comprehensively assess the financial performance indicators of petrochemical enterprises.

(2) Explanatory variables: Environmental regulation regulates various behaviors that pollute the public environment to achieve the goal of environmental protection by formulating policies and regulations, environmental standards, etc., including command-and-control, market-incentive, and social-public environmental regulation. See Table 1 for the definition of variable indicators.

(3) Mediating variable: The reduction of agency costs cannot be separated from high-quality environmental regulations, which have an impact on the financial performance of the firm. Therefore, the ratio of other receivables to total assets at the end of the period is chosen as a proxy variable in this paper.

(4) Control variables: In order to control the influence of other factors on agency costs and financial performance, five major indicators are selected, and the definition of variable indicators is shown in Table 1.

Table 1. Variable Indicator Definition.

Variable	Name	Mark	Definition
Explained variable	Command-controlled environmental regulation	ER1	LN (Penalties for environmental protection cases in the petrochemical industry by region+1)

	Market Incentive Environmental Regulation	ER2	Pollutant discharge fees and environmental protection taxes by region
	Social public environmental regulation	ER3	Public attention to the environment in the region where petrochemical enterprises are located
Explanatory variable	Corporate financial performance	FC	Calculation of comprehensive score by factor analysis method
Intermediary variable	agency cost	AC	Other receivables/total assets
Control variables	company size	FS	LN (Total enterprise assets at the end of the period)
	Equity concentration	OC	The proportion of shares held by the top 5 shareholders
	Listing age	AGE	LN (year of observation - a year of launch+1)
	Proportion of independent directors	IB	Independent directors/total number of directors
	Cash flow from operating activities	OCF	Net cash flow from activities/main business income

2.3 Model building

Combined with the actual petrochemical enterprise data, only the year is controlled. Therefore, the time-fixed effect model is used.

If environmental regulation can positively affect firm performance by suppressing agency costs, then it can be proved that agency costs play a mediating role in this model. Therefore, to test the hypotheses, three models are constructed separately.

$$FC = a_0 + a_1ER1 + a_2ER2 + a_3ER3 + a_4Control + \epsilon_1 \quad (1)$$

$$AC = \beta_0 + \beta_1ER1 + \beta_2ER2 + \beta_3ER3 + \beta_4Control + \epsilon_2 \quad (2)$$

$$FC = \theta_0 + \theta_1(ER1 + ER2 + ER3) + \theta_2AC + \theta_3Control + \epsilon_3 \quad (3)$$

3 Analysis of empirical tests

3.1 Descriptive Analysis

The results of the descriptive analysis are shown in Table 2.

Table 2. Descriptive analysis of variables.

VAR	N	Min	Max	AVG	Sd
FC	1980	-3.127	4.119	0.002	1.164
ER1	1980	0.000	9.747	5.257	2.684
ER2	1980	7.955	12.820	11.150	0.793
ER3	1980	2.854	6.458	5.044	0.659
AC	1980	0.000	0.251	0.013	0.022

3.2 Correlation analysis and collinearity test

This paper uses Pearson coefficient to analyze the correlation between variables and test multicollinearity. The following conclusions can be drawn from the results: (1) environmental regulations and corporate financial performance are positively correlated, and agency costs are negatively correlated with corporate financial performance, verifying hypotheses H1 and H2; (2) agency costs are significantly and negatively correlated with the three types of environmental regulations in general. (3) Using the variance expansion factor method to test the variables' multicollinearity, the mean value of the variables' VIF is 1.240, indicating no multicollinearity problem in the following regression analysis.

3.3 Analysis of regression results

3.3.1 Environmental regulation on financial performance of petrochemical enterprises

The main effects of environmental regulation on the financial performance of petrochemical firms. Adding other control variables, the regression coefficients of command-and-control, market-incentive, and social-public environmental regulations on the financial performance of enterprises are 0.0675, 0.1112, and 0.4094, respectively, indicating that environmental regulations have a significant positive effect on the financial performance of enterprises. This shows that petrochemical companies actively responding to environmental regulations can better achieve environmental protection investment, save energy, and reduce the cost of pollution control, thus conveying a good reputation to stakeholders, attracting social investment, and converting environmental regulatory pressure into a motivation to improve corporate financial performance. Therefore, hypothesis H1 is tested.

3.3.2 Agency costs of environmental regulation on the petrochemical industry

Table3 presents the regression results of environmental regulations on agency costs of petrochemical firms. The

regression coefficients of -0.0010, -0.0025, and -0.0037 for command-and-control, market-incentive, and social-public environmental regulations on agency costs are significantly negative at the 1%, 5%, and 5% levels, respectively, indicating that the three types of environmental regulations significantly inhibit agency costs. This indicates that environmental regulation pressure is an indirect resistance to the realization of the goal of maximizing shareholders' and managers' interests. Petrochemical companies, facing the improvement of external environmental regulation macro policy and multi-stakeholder regulation, will respond to environmental governance to protect the development of the company. Environmental costs inhibit their excessive on-the-job consumption, mitigating agency costs. Therefore, test hypothesis H2.

3.3.3 Analysis of intermediary effects of agency costs

Table 3 shows that the coefficients of the effects of agency costs on the financial performance of firms are -8.5658, -8.6953, and -8.4922, respectively, all of which are significantly negative at the 1% level. With the same control variables and the inclusion of agency costs, the coefficients of the effects of command-and-control, market-incentive, and social-public environmental regulations on the financial performance of petrochemical enterprises through the mediation of agency costs are 0.0586, 0.0897, and 0.3783, respectively, which exert significant effects at the 1%, 5%, and 1% levels, i.e., the three types of environmental regulations through agency costs have a positive effect on the financial performance of petrochemical enterprises. Agency cost is an essential influence on the financial performance improvement of petrochemical enterprises, so strong regulatory awareness, corporate environmental governance level, and internal agency conflicts under environmental regulation will be beneficial to the financial performance improvement of enterprises. Therefore, hypothesis H3 holds.

3.4 Robustness test

3.4.1 Regional Heterogeneity Test of Environmental Regulation on Financial Performance of Petrochemical Enterprises

The results of the regression analysis show that environmental regulations suppress agency costs and further test that the three types of environmental regulations have a significant positive effect on the financial performance of petrochemical companies in the East, Central, and West regions, and there is no significant regional difference in the level of suppression.

Table 3. Regression Results of the Impact of Environmental Regulation and Agency Cost on the Financial Performance of Petrochemical Enterprises.

VAR	FC	FC	FC	AC	AC	AC	FC	FC	FC
ER1	0.0675*** (3.61)			- 0.0010*** (-2.90)			0.0586*** (3.16)		
ER2		0.1112** (2.16)			-0.0025** (-2.35)			0.0897* (1.80)	
ER3			0.4094*** (5.30)			-0.0037** (-2.35)			0.3783*** (4.89)
AC							- 8.5658*** (-6.39)	- 8.6953*** (-6.52)	- 8.4922*** (-6.37)
CON	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y	Y
cons	0.4794** (2.26)	-0.6366 (-0.99)	- 0.9311*** (-2.60)	0.0196*** (4.88)	0.0456*** (3.37)	0.0312*** (4.04)	0.6477*** (3.07)	-0.2404 (-0.39)	-0.6664* (-1.85)
N	1980	1980	1980	1980	1980	1980	1980	1980	1980
r2	0.155	0.156	0.1623	0.1143	0.1132	0.113	0.1815	0.078	0.1885

3.4.2 Replacement Indicator Method for Testing Regression Analysis Results

To ensure the reliability of the empirical test, the explanatory variable (FC) is replaced by the return on equity (ROE) for robustness testing. ROE is a mainstream study of corporate financial performance and reflects the ability of a firm to earn net income from its capital, and a higher value of the indicator indicates that the firm is more efficient in using its own means.

4 Conclusions

The findings of this paper are as follows: (1) the Porter hypothesis is tested and the three types of environmental regulations have a significant positive impact on the financial performance of petrochemical firms; (2) environmental regulations suppress the agency costs of petrochemical firms and the pressure of environmental regulations will force shareholders and managers to pay attention to agency costs; (3) agency costs play a positive part in the process of environmental regulations to promote the financial performance of petrochemical firms. Based on the above findings, petrochemical companies should start from the perspective of environmental regulation.

Based on the above conclusions, firstly, it is necessary to enhance the awareness of social responsibility and internal environmental responsibility of petrochemical enterprises, and secondly, to improve the level of enterprise environmental management. The ultimate result will be reflected in the improvement of enterprise performance.

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