

Article

Environmental Regulation and Sustainable Growth of Enterprise Value: Mediating Effect Analysis Based on Technological Innovation

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Abstract: This research aims to analyze the nonlinear relationship among environmental regulation, technology innovation and enterprise value and provide a micro level of enterprise view on environmental regulation. Taking 1714 A-share listed companies in China's manufacturing industry from 2017 to 2020, a panel regression model was conducted to explore how environmental regulation influences enterprise value. The empirical research results show that: (1) the total effect of environmental regulation on enterprise value is U-shaped and that the technological innovation of enterprises has a partial intermediary effect between environmental regulation and enterprise value; (2) financial flexibility can significantly mitigate the impact of environmental regulations on enterprise value. This study provides a micro-level view of the influencing effect of environmental regulation on enterprise value.

Keywords: environmental regulation; technological innovation; enterprise value; financial flexibility



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1. Introduction

In recent years, China's economic development has made great achievements, but China also faces environmental issues, including resource consumption and waste pollutant accumulation, which are barriers to sustainable economic development [1]. China's environmental governance situation is deteriorating, which has become a bottleneck restricting the sustainable development of the economy, so it is urgent to strengthen environmental regulation. Environmental regulation is a kind of tangible or intangible binding force adopted by individuals or organizations for the purpose of improving the environment, and it imposes constraints on industry technical standards [2]. The different restraint modes can be divided into command control, incentive and voluntary forms. The command control form is formulated by administrative departments or legislative bodies to guide polluters to implement policies, regulations and systems conducive to environmental protection. The incentive form refers to government departments guiding enterprises in controlling pollution through market regulation. The voluntary form enables industry associations or enterprises to voluntarily participate in environmental protection agreements, commitments and plans. Environmental regulation in this paper refers to all kinds of environmental governance inputs carried out by enterprises based on the market.

Environmental regulation is a valuable way for the government to improve its high-quality economic development. Environmental regulation is a kind of restraint, which achieves the purpose of protecting the environment by constraining enterprises' behaviors [3]. Environmental regulatory policies can also guide enterprises in reducing pollution control costs and improving product competitiveness by means of green technology innovation, thus achieving a common development of environmental protection and performance [4]. In addition, the improvement of enterprise value can not only increase

local fiscal revenue, but also improve the local employment level and quality. Recently, the government has introduced many environmental regulatory policies in order to deal with the negative impact of economic growth and ensure sustainability between economic development and environmental protection.

However, strict environmental regulation is definitely a double-edged sword, which not only protects the public environment, but also has a negative impact on economic growth and enterprise value [5]. As environmental regulation has increased, manufacturers have had to buy or develop more advanced environmental technologies and equipment. Many companies believe this will increase their pollution control spending and then reduce their financial performance. However, do environmental regulations really inhibit the improvement of enterprise value?

The major debates on the relationship between environmental regulation and enterprise value have mainly four aspects: (1) environmental regulation has a positive effect on technology innovation and enterprise value. According to the Porter hypothesis, environmental regulation will benefit society and regulate firms by triggering dynamic efficiency, and the cost of compliance with environmental restrictions can be partially or completely offset by the promotion benefits [6]. Environmental constraints imposed by the government on enterprises can promote the accumulation of technological capital in enterprises, thus indirectly realizing the sustainable growth of enterprise value [7,8]. (2) Environmental regulation has a negative effect on technology innovation and enterprise value. Some studies believe that environmental regulation reduces non-green innovation funds of enterprises, hinders the product and process innovation of enterprises, and thus reduces enterprise business performance [9,10]. (3) Environmental regulation has no obvious effect on technology innovation and enterprise value. Some studies show that environmental regulations do not have much influence on the development of industries as well as enterprise technological innovation. (4) Environmental regulation has an uncertain effect on technology innovation and enterprise value. Some researchers classified the enterprises into light, medium and heavy pollution enterprises, but environmental regulation has a different impact on the innovation level and enterprise value. Other studies take the industries from different regions of the country and found different impacts of environmental regulation on technology innovation.

Hence, there is no consistent conclusion about the influence of environmental regulation on technology innovation and enterprise value. The current studies normally take the different regions and different industries as the sampling and find different conclusions. The debate about the relationship between environmental regulations on technology innovation and enterprise value became a hotly debated research topic. This paper aims to present and explore indicated research gaps and propose environmental regulation, technology innovation and enterprise value relationships as a theoretical model.

The paper is divided into five sections to understand the relationship between environmental regulation and enterprise value. The first section introduces China's manufacturing development situation and environmental protection policy. The second section presents the theoretical model and research hypotheses of this study. The third section describes the sampling, data sources, variables and model building. The fourth section presents the empirical test and research results, including statistics results, regression analysis, and empirical tests. Additionally, the last section summarizes the conclusion and implications of this research.

With the purpose of understanding the mechanism of how environmental regulation has an influence on enterprise value, this paper takes China's listed manufacturing companies as the research case to establish a relationship model between environmental regulation and enterprise value, explore the mediating effect of technological innovation between the two, and further test the moderating impact of financial flexibility. Finally, based on the research results and the current situation of China's economy and society, this paper proposes some policy suggestions to promote the coordinated development of China's economy and sustainable development.

2. Literature Review and Research Hypotheses

This study applies the theory of environmental regulation from the perspective of the Porter hypotheses. According to the new classical economics theory, environmental protection policies will increase private production costs and reduce the competitiveness of enterprises, thereby offsetting the positive effects of environmental protection on society and having negative effects on economic growth. However, Porter and Vender Linde and other scholars believe that the relationship between environmental protection and economic development cannot be simply divided into two sides. They agree that appropriate environmental regulations can promote enterprises to carry out more innovative activities, and these innovations will improve the productivity of enterprises, thereby offsetting the costs brought by environmental protection and improving the profitability of enterprises in the market.

2.1. Environmental Regulation and Enterprise Value

Environmental regulation is a kind of social regulation measure; in light of the excessive environmental pollution, government policy must be implemented to adjust enterprise and other economic activity to achieve environmental protection and coordinated economic growth targets, covering industrial pollution protection and urban environmental protection [11]. The effectiveness of environmental regulation is mainly reflected in correcting system failure, and many scholars and environmental regulation departments have put this into practice. In China, the strengthening of environmental supervision can mainly be achieved through environmental legislation, strict environmental standards and more effective pollution control measures. It should be recognized that, in most cases, environmental pollution is unavoidable, so prioritizing non-economic factors and adopting a one-size-fits-all regulatory policy are often undesirable. The most reliable form of regulation is to limit the amount of pollution that can be emitted.

Enterprise value is the present value of a firm's future free cash flow, which is discounted by the weighted average cost of capital. It is closely related to the management decisions of financial enterprises, reflecting the time cost, capital risk and sustainable development ability of enterprises. By extending enterprise value management, enterprise value can be defined as the legal value that can be followed and the core value of management, so that all stakeholders, including shareholders, managers, creditors, government and ordinary employees, can obtain satisfactory benefits. From a practical point of view, enterprise value is a common concept to measure the total value of a company, which can be regarded as the theoretical price to be paid for the complete acquisition of a company in a private transaction. Enterprise value considers not only equity value but also market value, meaning that all shareholder equity and debt-equity are included in the valuation. It is a popular concept among investors and analysts and is commonly used for financial ratios. Regarding the evaluation of enterprise value, most of the literature mainly selects indicators from the perspectives of the market and finance. Financial indicators include the return on equity (ROE), return on total assets (ROA), and growth rate of operating income, while market indicators include the sum of equity market value and net debt market value, overall enterprise value, book-to-market ratio, and Tobin's Q [12,13]. The relationship between environmental regulation and enterprise value has been studied for a long time, and most of the research results can be divided into three aspects.

The first aspect deals with the promoting effect; environmental regulation can improve an enterprise's long-term value by increasing the scale of enterprise environmental protection investment [13], but with a certain lag [12]. In addition, Gupta [14] conducted an empirical analysis using data from India, and the results of this study show that environmental sustainability and regulations have a positive and significant influence on the functional performance of firms. The second aspect is related to the inhibiting effect; the direct effect of environmental regulation has a significantly negative effect on enterprise performance [15], and this inhibiting effect is more obvious in highly polluting industries and enterprises [16]. Guan and Chen [17] took China's high-tech innovation industries as

the research background, used systematic and simultaneous efficiency measures for the overall research, and found that environmental regulations had a restraining effect on both the financial performance and non-financial performance of enterprises, and the restraining effect on financial performance was more obvious in the industries and enterprises who seriously polluted the central and eastern regions. Enterprise value can be divided into short-term value and long-term value, and the related research shows that market incentive environmental regulation in carbon emission trading pilot areas has a significant positive effect on the short-term value of enterprises, but a significant negative effect on the long-term value of enterprises [12].

The third aspect is related to the non-linear relationship; this kind of uncertain influence means that the effect of environmental regulation on the firm value may not be obvious or non-linear. Environmental protection and enterprise growth could achieve a win-win situation, and a single environmental protection action would neither reduce nor enhance enterprise value; that is, the value effect of environmental regulation is not significant [13]. Other scholars have found that the impact of environmental protection input on enterprise value was U-shaped, and corporate investment would have an impact on environmental regulation [17].

In fact, the government's environmental regulation, on the one hand, also leads to an increase in the cost of pollution control, a decrease in production and research and development funds, and a decline in corporate profitability, thus affecting corporate performance. In terms of cost-benefit analysis, the cost of environmental regulation and environmental protection input can be divided into explicit and implicit costs. Explicit cost refers to all the funds invested by enterprises in environmental protection, including the pollution discharge fees paid, the funds invested in the transformation of production lines to achieve cleaner production, and the environmental taxes paid. The hidden cost refers to the cost that enterprises may bear due to the environmental risk caused by the environmental behavior of enterprises.

On the other hand, this can enhance the environmental awareness of enterprises, improve the level of environmental governance of enterprises, improve their image and improve the market competitiveness of enterprises, as well as promote the improvement of enterprise value. According to the stakeholder theory, an enterprise is a contractual community composed of stakeholders. The stakeholders of an enterprise include not only internal stakeholders, such as shareholders, creditors, employees, suppliers and consumers, but also external stakeholders, such as government, media and social organizations. It even includes the natural environment, species, human offspring and other external objects directly or indirectly affected by business activities. Enterprises should generate income when conducting business activities; show appreciation to each stakeholder for their valuable resources; enable economic benefits; and realize the all-round development of politics, morality, culture and ecology.

In sum, this paper proposes the following research hypothesis:

Hypothesis 1 (H1). *When other conditions remain unchanged, the total effect of environmental regulation on enterprise value is U-shaped.*

2.2. The Mediating Effect of Technological Innovation

To understand technological innovation, we must first know the definition of innovation. Innovation is the implementation of new or significantly improved products, services or processes, new marketing methods or new ways of organizing external relations, business activities, workplace organizations or practices. Technological innovation refers to innovation in processes and products by developing or implementing new technologies to optimize performance and results [18]. Technological innovation has two perspectives: macro-perspective and micro-perspective. This paper mainly starts from the perspective of microenterprises. At present, there are two main methods to measure enterprise technological innovation: the input and output methods. Indicators selected by the input method

mainly include the logarithm of R&D investment and the ratio of R&D investment to operating revenue [19]. Indicators selected by the output method mainly include the number of patent applications (authorized) and invention patent applications (authorized) [20].

At present, there are few studies based on establishing a relationship model among environmental regulation, technological innovation and enterprise value, and most of them are concerned with the relationship between the two. There are basically three views on the relationship between environmental regulation and technological innovation [21]: The first considers the facilitation perspective; environmental regulation could significantly influence technological innovation [22]. The impact of environmental regulations on enterprise innovation proves that environmental regulation can improve innovation productivity to a large extent, especially for state-owned enterprises, pollution-intensive industries and high-tech intensive industries [23]. Compared with command-based environmental regulation, market-oriented environmental regulation and voluntary environmental regulation had a more obvious driving effect on enterprise innovation [24].

The second is related to the inhibition perspective: Scholars constructed an experiment of China's carbon emission trading pilot policy and found that the pollution paradise effect caused by the carbon emission trading pilot policy offset the Porter effect to some extent [25]. Other scholars divided environmental regulation tools into three types, namely, public voluntary, command-control and economic incentive, and found that all three types of environmental regulation tools inhibit technological enterprise innovation at the national level, and neither a "strong" nor a "weak" Porter hypothesis can be established [26].

The third is concerned with the perspective of nonlinearity or heterogeneity; some scholars divide environmental regulation into multiple categories [27], and the results show that different types of environmental regulation tools have significant differences in terms of their effects on technological innovation [28,29]. Some other scholars have explored the connection between environmental regulation and technological innovation based on data from different regions [30] and believed that the innovation effect of environmental regulation has regional and industrial heterogeneity [31,32]. Other scholars also believe that the relationship between environmental regulation and technological innovation is U-shaped [33], N-shaped and folded [34,35].

Regarding the effect of technological innovation on enterprise value analysis, most current scholars agree that enterprises can increase their investment in technology innovation [36] to achieve production technology, product, facility, organization and management innovations and, in turn, to reduce production costs and improve enterprise competitiveness. This will eventually generate more profits for the enterprises and improve the enterprise value [37]. In addition, a small number of scholars believe that the relationship between the number of patents and the enterprise value is non-linear, and with the increase in the number of patents, the enterprise value will increase first and then decrease [38].

In sum, this paper proposes the following research hypothesis:

Hypothesis 2 (H2). *If other conditions remain unchanged, the technological innovation of enterprises has a partial mediation effect on environmental regulation and enterprise value.*

The theoretical model of environmental regulation, technological innovation and firm value is shown in Figure 1.

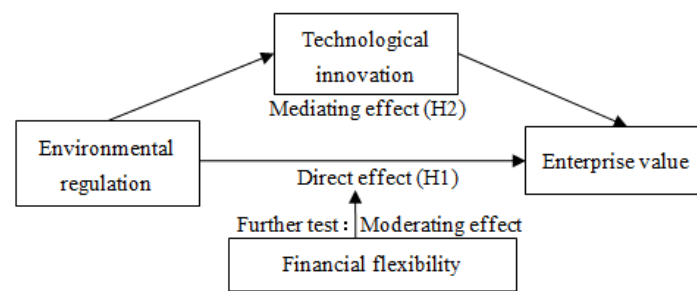


Figure 1. Theoretical model diagram of this paper.

3. Research Methods and Data

3.1. Variable Selection

3.1.1. Explained Variable

The measurement indicators of enterprise value can be mainly divided into financial indicators and market indicators. Financial indicators are used to measure the short-term value of enterprises, while market indicators are used to measure the long-term value of enterprises [39]. Since this paper aims to explore the impact of environmental regulation on the long-term interests of enterprises in the future, market indicators are selected to measure the long-term value of enterprises. Referring to previous studies, Tobin's Q was adopted as a relative index to measure the long-term value of enterprises [40,41].

3.1.2. Explanatory Variable

The intensity of environmental regulation can be measured at the macro- and microlevels. However, due to the serious lack of data on environmental protection investment and pollutant discharge at the microlevel of manufacturing enterprises, this paper chose to measure the intensity of environmental regulation suffered by city-owned enterprises using the urban pollutant discharge index. The ratio of urban industrial wastewater discharge to regional GDP was adopted to represent the degree of environmental regulation that enterprises in the city are subjected to [28]. The impact of environmental regulation on enterprise value has a lag, so this paper took the lag period of environmental regulation as an explanatory variable for regression, which also excludes endogenous problems to a certain extent [15].

3.1.3. Intermediate Variable

The measurement of technological innovation mainly includes the input and output methods. The technological innovation of enterprises from the perspective of the input method, that is, the ratio of R&D investment and operating income was selected to represent the technological innovation level of enterprises [37].

3.1.4. Control Variables

There are many ways in which control variables affect enterprise value. Referring to previous studies, combined with the significance level and the principle of $VIF < 3$, the control variables selected in this paper include: capital structure, which is represented by the asset–liability ratio; enterprise scale, which is expressed as the log value of the total assets of the company at the end of the period; the net operating cash flow is expressed by the ratio of the annual net cash flow from operating activities to the total assets at the end of the period; the return on equity is the ratio of after-tax profits to net assets. In addition, two dummy variables, industry and year were added. The following Table 1 describes the list of variables in this study [38].

Table 1. List of variables.

Term	Variable	Code	Distribution
Explained variable	Enterprise value	TQ	(Equity market value + net debt market value)/total assets at the end of the period
Explanatory variable	Environmental regulation	Ers	Industrial wastewater discharge of the city/GDP of the city
Intermediate variable	Technological innovation	TEC	R&D expenses/revenue
Control variables	Capital structure	Lev	Total ending liabilities/total ending assets
	Enterprise scale	Size	Log of total assets at the end
	Cash flow	OCF	Net cash flow from operating activities/total assets at the end
	Return on equity	ROE	After-tax profit/net assets
	Industry	Ind	Classify manufacturing enterprises according to secondary industry codes
	Year	Year	The sample range is 2017–2020

3.2. Model Construction

In order to explore the impact of environmental regulation on enterprise value and verify the partial mediating effect of technological innovation between the two, this paper constructed the following model by referring to the mediating effect testing procedure proposed by Wen and Ye [38]:

In Equations (1)–(3), A , B and C are constant terms; ε_{it} is the random disturbance term; $\sum \delta_i Ctrl_{it}$ is the sum of the product of control variables and their regression coefficients. TQ_{it} represents the enterprise value of the explained variable, Ers_{it} and Ers^2_{it} represent the environmental regulation and its secondary term of the explanatory variable, and TEC_{it} represents the technological innovation of the intermediary variable.

Formula (1) aims to explore the total nonlinear effect of environmental regulation on enterprise value, and the influence coefficient is denoted as c_2 and c_3 .

$$TQ_{it} = A + c_2 Ers_{it} + c_3 Ers^2_{it} + \sum \delta_i Ctrl_{it} + \varepsilon_{it} \quad (1)$$

Equation (2) aims to explore the nonlinear relationship between environmental regulation and enterprise technological innovation, and the influence coefficients are a_1 and a_2 .

$$TEC_{it} = B + a_1 Ers_{it} + a_2 Ers^2_{it} + \sum \delta_i Ctrl_{it} + \varepsilon_{it} \quad (2)$$

Formula (3) aims to explore whether environmental regulation and technological innovation have significant influences on enterprise value at the same time. B is the influence coefficient of technological innovation on enterprise value, and c_1 is the direct effect of environmental regulation on enterprise value.

$$TQ_{it} = C + c_1 Ers_{it} + b TEC_{it} + \sum \delta_i Ctrl_{it} + \varepsilon_{it} \quad (3)$$

The results of joint Models (1)~(3) are as follows: if the coefficients a_1, a_2, b, c_2, c_3 are significant, it indicates that technological innovation has a mediating effect on the relationship between them. For the further test coefficient c_1 , if c_1 is not significant, it indicates only the mediation effect, namely, the complete mediation effect. If c_1 is significant, a partial mediation effect exists.

3.3. Data Sources

This paper chooses the Chinese A-share listed manufacturing companies from 2017 to 2020 as the research samples. To ensure the validity of the data, this paper screened

the collected manufacturing enterprise data as follows: (1) the companies that were ST or *ST during the sample period were excluded; (2) some companies not belonging to the manufacturing industry in the year were excluded; (3) companies with missing data or obvious anomalies were eliminated. After the above screening, 1714 sample companies were obtained, with a total of 6856 observed values. Among them, the data on environmental regulation were obtained from the China Urban Statistical Yearbook, and other data were obtained from the CSMAR Database. In addition, multiple linear regression, mediating effect and moderating effect models were adopted; and STATA 17 and other econometric software were used to compare and study the relationship between environmental regulation, enterprise technological innovation and enterprise performance or value from the perspectives of a full sample and subsample.

3.3.1. Descriptive Statistical Analysis

Before descriptive statistics, in order to reduce the possibility of pseudo-causality caused by outliers, the winsorization of the upper and lower 1% was applied to all the continuous variables in this paper. The descriptive statistical results of major variables are shown in Table 2. It can be seen from the table that: (1) The mean values of all variables are close to the median, so under the condition of large samples, the data can be considered to be generally close to normal distribution. (2) The mean enterprise values, environmental regulation and technological innovation are all slightly higher than the median; that is, more than half of the enterprises or the annual level of enterprise value, environmental regulation and technological innovation are lower than the average level of the sample. (3) The standard deviation of the capital structure, net operating cash flow and return on equity are all less than 1; the standard deviation of the enterprise value, environmental regulation and enterprise size is slightly more than 1; the standard deviation of technological innovation is 4.553, but the dispersion coefficient is less than 1, indicating that the above variables show little difference between the enterprises and the year, and the data are relatively stable. (4) The 75% quantile of capital structure is 52.3%, that is, less than 60%, indicating that most manufacturing enterprises have relatively conservative financial strategies and small financial leverage.

Table 2. Descriptive statistics of variables.

Variable	Minimum Value	Maximum Value	Mean	Standard Deviation	Percentile		
					25%	50%	75%
TQ	0.849	9.890	2.385	1.587	1.378	1.891	2.795
Ers	0.218	5.412	1.473	1.180	0.618	1.165	1.902
TEC	0.061	26.000	5.238	4.553	2.537	4.138	6.481
Lev	0.067	0.818	0.390	0.178	0.247	0.386	0.523
Size	20.036	25.791	22.143	1.191	21.277	21.999	22.808
OCF	−0.116	0.239	0.056	0.064	0.017	0.053	0.094
ROE	−0.662	0.347	0.063	0.129	0.031	0.071	0.119

3.3.2. Correlation Analysis

Before regression analysis, Pearson's correlation test was conducted on the main variables, and the results are shown in Table 3. As shown in the table, Pearson's correlation coefficients of environmental regulation, technological innovation and enterprise value are all significant, laying a foundation for regression analysis. Among them, the correlation coefficients between environmental regulation and technological innovation, and between environmental regulation and enterprise value, are all less than 0.1, and both are negative, indicating that there may be a non-linear relationship between these two pairs of variables. The correlation coefficients between control variables and explained variables or mediators

are also significant at the 0.01 level. In addition, the correlation coefficients between explanatory variables and control variables are both less than 0.5, indicating that there is no serious multicollinearity between explanatory variables and control variables.

Table 3. Correlation between variables.

Variable	TQ	Ers	TEC	Lev	Size	OCF	ROE
TQ	1						
Ers	−0.0254 **	1					
TEC	0.3189 ***	−0.0725 ***	1				
Lev	−0.2512 ***	−0.0198	−0.2313 ***	1			
Size	−0.3065 ***	−0.0442 ***	−0.2652 ***	0.4901 ***	1		
OCF	0.1726 ***	0.0478 ***	−0.0646 ***	−0.1668 ***	0.0796 ***	1	
ROE	0.1518 ***	0.0478 ***	−0.0554 ***	−0.1866 ***	0.1108 ***	0.3622 ***	1

Note: *** $p < 0.01$, ** $p < 0.05$.

4. The Empirical Test and Results

4.1. Regression Analysis

To further explore the impact of environmental regulation on enterprise value and the mediating effect of technological innovation between the two, this paper adopted the three-step test of the mediating effect, and the results are shown in Table 4. In the second column, the total effect of environmental regulation on enterprise value is explored. The coefficients of primary and secondary terms are -0.170 and 0.045 , respectively, and both are significant at the level of 1%. This shows that the total effect relationship between the environmental regulation and enterprise value of manufacturing enterprises is U-shaped. According to the calculation, the axis of symmetry of the curve is $Ers = 1.889$; that is, there are 5141 observed values on the left of the axis of symmetry, and the remaining 1715 observed values are on the right of the axis of symmetry. Therefore, the degree of environmental regulation from the Chinese government on most manufacturing enterprises is insufficient; that is, the degree of environmental regulation needs to be strengthened, so the overall effect is mostly negative.

As can be seen from the third column, the regression coefficients of primary and secondary terms of environmental regulation on enterprise technological innovation are -0.726 and 0.183 , respectively, and both are significant at the level of 1%. This indicates that with the increase in the intensity of environmental regulation on manufacturing enterprises, the technological innovation of enterprises presents a U-shaped dynamic feature of decreasing first and then increasing, and the symmetry axis of the U-shaped curve is $Ers = 1.984$. By further checking the original data, it is found that there are 5223 observed values less than 1.984, and another 1633 observed values greater than 1.984, which indicates that the impact of environmental regulations on the technological innovation of Chinese manufacturing enterprises is mostly a restraining effect, and only a few enterprises can stimulate technological innovation through environmental regulations. This indicates that the majority of manufacturing enterprises are affected by environmental regulations, which negatively offset the technological innovation activities of enterprises, and only a few enterprises play an innovation compensation role. Considering the intensity of environmental regulation itself, it also indicates that the intensity of environmental regulation for manufacturing enterprises by the Chinese government is insufficient, and it cannot play its due role in promoting innovation.

On the basis of the first step, this paper adds the technological innovation variable as an explanatory variable for regression, and finds that the quadratic term of environmental regulation is not significant, but the primary term is significant; that is, the nonlinear relationship is not established. Therefore, this paper only takes one item of environmental regulation for regression, and the result is shown in the fourth column: the regression coefficient of enterprise technological innovation on enterprise value is 0.099 , which is significant at the 1% level. This shows that the technological innovation of manufacturing

enterprises has a significant promoting effect on the improvement of enterprise value. Considering the U-shaped influence of environmental regulation on enterprise technological innovation and the promotion effect of enterprise technological innovation on enterprise value, it can be concluded that for most manufacturing enterprises, environmental regulation can indirectly inhibit the improvement of enterprise value by inhibiting technological innovation. The environmental regulation of a few manufacturing enterprises can promote technological innovation and then promote the overall value of enterprises. The reason for this situation lies in that the intensity of environmental regulation of most manufacturing enterprises by the Chinese government is still insufficient (on the left end of the symmetry axis), so environmental regulation cannot effectively lead to the technological innovation of enterprises.

Table 4. Results of regression analysis.

Variable	TQ (First Step)	TEC (Second Step)	TQ (Third Step)
Ers	−0.170 *** (0.021)	−0.726 *** (0.068)	−0.049 *** (0.013)
Ers2	0.045 *** (0.009)	0.183 *** (0.025)	
TEC			0.099 *** (0.006)
Lev	−0.762 *** (0.134)	−4.894 *** (0.341)	−0.279 ** (0.129)
Size	−0.470 *** (0.020)	−0.600 *** (0.048)	−0.408 *** (0.020)
OCF	4.436 *** (0.339)	0.713 (0.891)	4.351 *** (0.328)
ROE	1.981 *** (0.195)	−2.451 *** (0.513)	2.226 *** (0.189)
Ind	control	control	control
Year	control	control	control
Constant	13.299 *** (0.418)	19.877 *** (1.048)	11.242 *** (0.420)
Adj-R2	0.2631	0.2292	0.3227
F	189.62	169.83	215.29
N	6856	6856	6856

Note: ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses.

Based on the above three-step regression analysis, it can be concluded that technological innovation has a very significant partial mediating effect between environmental regulation and enterprise value when other conditions remain unchanged.

4.2. Robustness Test and Heterogeneity Test

In order to test the robustness of the above regression results, this paper used the method of replacing the main variables for a second verification. This paper selected three pollution emission indicators, namely, industrial wastewater discharge, industrial sulfur dioxide discharge and industrial smoke and dust discharge, to calculate the ratio with the gross regional product, and then establishes the environmental regulation (ERS) intensity index through principal component analysis. This paper adopted the sum of the company's year-end equity market value and net debt market value as the enterprise value (EV) measurement index. In order to alleviate the heteroscedasticity problem, this variable was logarithmic processing. Finally, this paper adopted the log value of annual R&D expenses of enterprises as the measurement index of enterprise technological innovation (RD). After

the above variables were replaced, the research samples were divided into state-owned and non-state-owned enterprises according to property rights, and then sample regression was conducted to test the above research assumptions. The results are shown in Table 5; the results obtained in the full sample and state-owned and non-state-owned enterprises are basically consistent with those in Table 4. Research hypotheses H1~H2 are still valid, indicating that the above conclusions have strong robustness.

Table 5. Robustness test results and heterogeneity test results.

Variable	Full Sample		State-Owned Enterprises			Non-State-Owned Enterprises			
	EV	RD	EV	EV	RD	EV	EV	RD	EV
ERS	−0.060 *** (0.006)	−0.255 *** (0.020)	−0.025 *** (0.004)	−0.041 *** (0.009)	−0.287 *** (0.041)	−0.016 *** (0.005)	−0.064 *** (0.007)	−0.216 *** (0.021)	−0.032 *** (0.007)
ERS2	0.0026 *** (0.0004)	0.010 *** (0.001)		0.0017 *** (0.0005)	0.012 *** (0.002)		0.0026 *** (0.0004)	0.010 *** (0.002)	
RD			0.059 *** (0.006)			0.027 *** (0.007)			0.081 *** (0.007)
Ctrl	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind	control	control	control	control	control	control	control	control	control
Year	control	control	control	control	control	control	control	control	control
Constant	4.232 *** (0.112)	−0.398 *** (0.294)	4.233 *** (0.110)	3.417 *** (0.222)	−1.836 ** (0.842)	3.434 *** (0.224)	4.451 *** (0.138)	−0.493 ** (0.317)	4.479 *** (0.133)
Adj-R2	0.8859	0.4996	0.8884	0.9147	0.4716	0.9153	0.8606	0.5344	0.8651
F	3710.94	558.37	3826.15	1120.15	149.52	1133.48	2283.58	427.45	2439.97
N	6856	6856	6856	1699	1699	1699	5157	5157	5157

Note: ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses.

The grouped regression results also show that the corresponding coefficients of manufacturing enterprises with different property rights are slightly different. First, the relationship between the environmental regulation and enterprise value of state-owned enterprises and non-state-owned enterprises presents a U-shaped curve. Second, regardless of whether enterprises are state-owned or non-state-owned, environmental regulation and technological innovation have a U-shaped curve relationship, but the axis of symmetry and vertex are slightly different. Third, the direct negative effect of environmental regulation on the enterprise value of state-owned enterprises and non-state-owned enterprises is -0.016 and -0.032 , respectively. SUEST (based on the SUR test of a seemingly unrelated model) shows that the p -value = $0.0547 < 0.1$. Therefore, the direct effects of environmental regulations on the enterprise value of manufacturing enterprises with different property rights are significantly different; that is, the direct negative effects of environmental regulations on the enterprise value of non-state-owned enterprises are significantly greater than those of state-owned enterprises. Fourth, the regression coefficients of technological innovation of state-owned enterprises and non-state-owned enterprises on enterprise value are 0.027 and 0.081 , respectively. The SUEST test results show that the p -value is < 0.0001 , so there are extremely significant differences in the promotion effect of technological innovation of manufacturing enterprises with different property rights on enterprise value; that is, the positive effect of the technological innovation of non-state-owned enterprises on enterprise value is significantly greater than that of state-owned enterprises.

4.3. Further Study

It has been shown in a previous review that an increase in environmental protection expenditure caused by environmental regulation will diminish the production and R&D funds of enterprises, cause investment opportunities to be missed, and then lead to a decline

in corporate profits. Companies with excellent financial flexibility can survive tough economic times and take advantage of unexpected investment opportunities [42]. In addition, the improvement of financial flexibility can inhibit the negative relationship between the carbon emission trading mechanism and the long-term value of enterprises [39]. Therefore, this paper introduces the variable of financial flexibility to further explore whether financial flexibility has a moderating effect on the relationship between environmental regulation and enterprise value.

There are few relevant studies on the moderating effect of financial flexibility between environmental regulation and enterprise value. However, most scholars have explored the impact of financial flexibility on enterprise performance, and almost all of them show that financial flexibility has a driving effect on enterprise value. The main reason for this is that maintaining a certain degree of financial flexibility provides necessary funds for the temporary financing of enterprises, reduces financing costs, and at the same time captures investment opportunities and enhances enterprise value [43,44]. Moreover, the better the financing of an enterprise, the more prominent the contribution of financial flexibility to marginal value and enterprise value will be [45]. In addition, when an enterprise is confronted with a major shock and cash shortage, financial flexibility also plays a buffer role [46], and there are significant differences in the buffer effect of the financial flexibility of enterprises with different property rights and different scales [47,48].

Before regression analysis, relevant variables need to be measured and processed. First, financial flexibility (FF) was defined as the sum of cash flexibility and liability flexibility, where cash flexibility = (the cash ratio of enterprise *i*—the average cash ratio of the secondary industry) and debt flexibility = Max (0, the average debt ratio of the secondary industry—the debt ratio of enterprise *i*). Then, to alleviate the multicollinearity problem, the variables of environmental regulation and financial flexibility were centralized in this paper; that is, each observed value of environmental regulation (financial flexibility) was subtracted from the mean of all the observed values of environmental regulation (financial flexibility). Finally, the centralized environmental regulation and the centralized financial flexibility were multiplied to obtain the interaction term (Ers_FF_), which is also the regulating effect term.

In the regression analysis, this paper constructed three regression models to gradually explore the moderating effect of financial flexibility, as shown in Models (4) and (5) are shown below. Among them, the first model is completely consistent with the previous Model (3), which is used to explore the direct impact of the environmental regulation degree on the enterprise value level. The second model is Model (4), which is used to explore the effect of financial flexibility on enterprise value. The third model is Model (5), which adds the interaction term of environmental regulation and financial flexibility to explore the moderating effect of financial flexibility on the relationship between environmental regulation and enterprise value.

$$TQ_{it} = D + \alpha_1 Ers_{it} + \beta_1 FF_{it} + \sum \delta_i Ctrl_{it} + \varepsilon_{it} \quad (4)$$

$$TQ_{it} = E + \alpha_2 Ers_{it} + \beta_2 FF_{it} + \beta_3 Ers_FF_ + \sum \delta_i Ctrl_{it} + \varepsilon_{it} \quad (5)$$

The financial flexibility (FF) and interaction term (Ers_FF_) indexes were substituted into the three-step model of the moderating effect, and the results are shown in Table 6. It can be seen from the second column that environmental regulation has a direct inhibitory effect on enterprise value. However, it can be seen from the third column that enterprise financial flexibility can promote the improvement of enterprise value, which is consistent with the review of the existing literature. The interaction terms were added based on the third column to obtain the test results of the moderating effect, as shown in the fourth column. The influence coefficient of interaction terms on enterprise value is 0.211, which is significant at 5%. This shows that financial flexibility can alleviate the direct inhibition effect of environmental regulation on enterprise value; that is, when environmental regulation has an impact on enterprise value, maintaining a certain degree of financial flexibility can play

a buffer role. The reasons are as follows: environmental regulations will diminish corporate funds and then reduce corporate performance. However, if the enterprise maintains a certain degree of financial flexibility, including surplus cash and low debt levels, when the environmental regulation of enterprises requires additional capital, enterprises can use their existing cash and cash equivalents, without the need to access R&D or production, thus reducing the direct inhibition effect of environmental regulation on enterprise value.

Table 6. Moderating effect of financial flexibility.

Variable	TQ	TQ	TQ
Ers	−0.049 *** (0.013)	−0.041 *** (0.013)	−0.038 *** (0.014)
TEC	0.099 *** (0.006)	0.095 *** (0.006)	0.096 *** (0.006)
FF		1.250 *** (0.152)	1.275 *** (0.152)
Ers_FF_			0.211 ** (0.106)
Ctrl	Yes	Yes	Yes
Ind	control	control	control
Year	control	control	control
Constant	11.242 *** (0.420)	10.961 *** (0.411)	10.951 *** (0.411)
Adj-R2	0.3227	0.3330	0.3337
F	215.29	204.12	190.55
N	6856	6856	6856

Note: ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses.

5. Conclusions and Implications

5.1. Conclusions

According to the literature review on the relationship among environmental regulation, technology innovation and enterprise value, this study takes the manufacturing industry from 2017 to 2020 as a database, and analyses the relationship between environmental regulation and enterprise value, as well as the mediating effect of technology innovation and the moderating effect of financial flexibility.

In sum, the main conclusions of this study are as follows: (1) The total effect of environmental regulation on enterprise value is U-shaped. (2) The relationship between the environmental regulation and technological innovation of manufacturing enterprises presents a U-shaped curve; that is, with the increase in the environmental regulation degree, the technological innovation of manufacturing enterprises decreases first and then increases. (3) Technological innovation has a partial mediating (hiding) effect between environmental regulation and firm value; that is, environmental regulation can indirectly change the firm value by influencing technological innovation. (4) Maintaining a certain degree of financial flexibility can not only significantly promote enterprise value directly, but also alleviate the impact of environmental regulations on enterprise value.

This study proves that environmental regulation has an uncertain nonlinear effect on enterprise value, which agrees with some scholars' research results. At the same time, this study proves that technological innovation has a mediating effect and financial flexibility has a moderating effect, it extends the research on the relationship between environmental regulation and enterprise value. Despite this, current research mainly concerns the industrial and regional samples, this study makes up the gap by using enterprise-level samples.

5.2. Implications

China's economy has changed from high-speed growth to high-quality development, and environmental protection has become an important way to achieve high-quality national economic development. As an important entity of economic development, how to improve the effectiveness of environmental regulation policies for manufacturing enterprises is the current focus of the government. In view of the above problems, this paper draws the following conclusions through empirical analysis: (1) The government should consider the local economic development level and enterprise development status quo of objective factors, and find the best way to improve environmental regulation policy to effectively guide enterprises from passively accepting environmental regulation to actively adapting to the constraints of environmental regulation. (2) The government should appropriately strengthen the environmental supervision of manufacturing enterprises and formulate stricter environmental supervision policies. (3) Enterprises should establish and improve the financial flexibility system, formulate reasonable financial flexibility evaluation methods, appropriately increase corporate capital reserves, and maintain the most effective use of corporate capital at any time. (4) Enterprises can actively cooperate with more environmental policies and increase their investment in pollution control to shift the degree of environmental regulation to which they are subjected to the right end of the axis of symmetry.

5.3. Future Research

There is a lack of joint research on environmental regulation, technological innovation and enterprise value in the literature, and the research objects are mostly at the macro-provincial level or the whole industry level; there is little analysis at the microenterprise level in the manufacturing industry. The research within this paper complements the existing research and explores the intermediate mechanism and path between environmental regulation and enterprise value. However, there are still some gaps in the research, which must be further studied and expanded in the future. The main shortcoming and future directions of this paper are as follows:

First, in terms of research objects, although 1714 A-share listed companies in the manufacturing industry were selected for the study, non-listed manufacturing enterprises were not included. In the future, the authors will collect more data on unlisted companies and conduct a comparative analysis with the research in this paper. At the same time, it is also hoped that in the future, when more scholars study such problems, they can attempt to include non-listed companies and perform grouped regression.

Second, in terms of variable measurement, this paper adopted the ratio of pollutant emissions to the GDP of a prefecture-level city to measure the intensity of environmental regulation. The authors will attempt to collect more indicators of individual enterprises' environmental protection investment, pollution control investment and pollutant discharge in the future, to obtain more accurate analysis results.

Third, in terms of mediating variables, considering the serious lack of enterprise green technology innovation data, this paper only adopted the overall enterprise technological innovation as a mediating variable for analysis. Technological innovation can be divided into green and non-green technological innovation. In the future, the authors will attempt to collect as much data as possible to measure green enterprise technological innovation and conduct grouped regression or difference analysis with the results of non-green technological innovation.

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