

Research on R&D Expenditure and Financial Performance in Perspective of Environment Regulation

-- Based on Chinese Manufacturing Listed Companies

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Abstract

Since the reform and opening up, China's socialist market economy has developed by leaps and bounds. However, the contradiction between environmental problems and economic development has become sharper and sharper. Faced with such problems, the government has promulgated many laws and regulations related to large and small, which reflects the state's high regard for listed companies in dealing with environmental issues. Many companies have expressed their support for national policies and began to formulate environmental protection rules and regulations within the company to create an environment-friendly enterprise. Based on the related theory, this paper takes the financial and environmental data of China's Shanghai and Shenzhen A-share manufacturing enterprises from 2014 to 2019 as a sample, empirically studies the impact of environmental regulation on corporate R&D investment and financial performance in the context of environmental regulation policies.

Keywords

Environment Regulation; R&D Expenditure; Financial Performance.

1. Introduction

Faced with the problem of environmental pollution, the Chinese government has issued a number of related regulatory policies. This series of regulatory documents shows that the state attaches great importance to listed companies' handling of environmental protection and financial performance growth. Many companies have responded to national policies and began to formulate their own environmental protection methods to strengthen their internal environmental protection efforts. However, for some listed companies, the cost has risen as a result. Many listed companies have not yet found an effective way to deal with environmental supervision. In-depth research on how to alleviate the contradiction between the earth's ecological environment and the rapid economic development is an urgent issue. Before Porter, scholars generally believed that environmental regulations inhibited companies from conducting research and development, and environmental protection expenditures would occupy corporate R&D funds. Porter believes that although environmental regulations do occupy a certain amount of resources and produce a "crowding effect", reasonable and effective regulations will also produce an "innovation compensation effect", which can more stimulate enterprises to innovate corresponding technologies. In today's general environment, it is even more necessary to pay more attention to the research on the relationship between corporate R&D investment and financial performance under environmental regulations.

2. Related Concepts and Theoretical Basis

2.1. Environment Regulation

Here, the environmental regulation is understood as: the relevant departments promulgate laws, regulations, rules and regulations related to environmental protection, energy conservation and emission reduction, make reasonable guidance for the production and operation decisions of enterprises, and act as a visible hand to influence the allocation of resources in the market[1]. Encourage enterprises to carry out appropriate process innovation and product innovation to meet regulatory requirements, and ultimately achieve the goal of maximizing corporate value and a win-win situation where environmental problems can be resolved. The government's regulation of the environment is to coordinate the environment and the economy as much as possible, to achieve pollution in the established environmental space far below the environmental load capacity, to achieve sustainable economic development, continuous and quality growth of GDP.

2.2. Research and Development

OECD thinks that R&D is a system-based original behavior to obtain theoretical knowledge about humans, society, and culture and to further transform that knowledge into inventions and innovations. In the International Accounting Standards, it is divided into two aspects: research phase expenditure and development phase expenditure. The research phase is a planned exploratory scientific research activity to master new theories and technologies, and the development phase is determined after the research phase. Before the business plan, the results of the preliminary research are used in a certain plan, and then the product is produced with substantial innovation and improvement.

2.3. Technical Innovation Theory

Joseph Alois Schumpeter emphasized that under the current circumstances, the development of the capitalist economy relies on technological innovation and institutional innovation, and explained the performance of each stage of the business cycle and the reasons for its emergence. Here, innovation is not only limited to product innovation, but includes reform and innovation in five aspects: products, production materials, production processes, product markets, and organizational forms [2]. It is proposed in the theory of technological innovation that the value-added of an enterprise can be realized by upgrading the raw materials of production equipment and improving the combination of various production factors and production processes, which will drive the continuous economic growth of the entire society. With the rapid economic development today, large-scale enterprises with better economic conditions will carry out technological innovation when improving production and expanding the market. To successfully achieve technological innovation, R&D activities are indispensable. Research and development can bring continuous technological innovation, optimization of production processes, reduction of production costs, product innovation, improvement of customer satisfaction, and seizure of market opportunities, which are ultimately reflected in the improvement of financial performance. Under environmental regulations, green technological innovation is the focus of enterprises. In terms of innovation objects, there are three types of green technological innovation: green process innovation, green product innovation, and end-point management technology innovation.

2.4. Porter Hypothesis

There is no contradiction between the protection of environmental resources and economic development, and the government should fully assume the responsibility of supporting and guiding enterprises to carry out green innovation. This is because when the regulated company improves its process, replaces raw materials, pays fines, etc., which lead to higher costs,

negative emotions will resist the regulatory policies, resulting in the failure of management and governance to make ineffective communication and decision-making. In this case, Reasonable and effective government regulations, such as direct environmental protection subsidies, tax reductions and exemptions, can positively encourage enterprises to carry out green technological innovation, and achieve innovation compensation effects in the long run. And in terms of obtaining market information, the government has an absolute advantage over enterprises. It can provide enterprises with cutting-edge information on green innovation and continue to guide enterprises in green innovation[3,4].

Porter's theory is mainly divided into: innovation compensation theory and first mover advantage theory. Innovation compensation theory points out that the impact of environmental regulations on corporate value should be viewed from a long-term dynamic perspective. Environmental regulatory policies may increase the cost of enterprises in the short term and temporarily reduce their profits; but in the long run, a properly designed regulatory policy can guide enterprises to take the initiative in research and development. The production efficiency of enterprises will eventually be improved due to the innovation of production technology and equipment. The new products developed can promote the diversification of products and improve the market position of enterprises, offset the increase in production costs due to environmental regulations, and produce the result of innovation compensation. The theory of first-mover advantage shows that, as the green consumption wave sweeps the world today, ordinary consumers have an increasing preference for environmentally-friendly products, and companies must achieve product diversification through green technological innovation. If a country implements a strict environmental regulation system, companies in that country will quickly carry out green technological reforms to companies in countries with weak environmental regulations and launch environmentally friendly products to occupy market share, while other companies will be at a disadvantage in the competition.

3. Research Hypothesis

3.1. Environmental Regulations Affect Corporate R&D Investment

The environmental regulations and policies implemented by the government have become increasingly stringent, such as charging pollutant discharge fees for enterprises. The manpower, material and financial resources invested by enterprises for pollution control have increased costs and reduced their profits. In order to better reduce production costs, they must be forced to carry out technological innovation; in addition, the state has also given active environmental protection while penalizing pollution control. Protected corporate financial subsidies, tax reductions and exemptions, etc., reduce the risk of companies financing technological innovation. Nowadays, the concept of environmental protection has been deeply rooted in the hearts of the people, and consumers' awareness of environmental protection has also been increasing. Green and environmentally friendly products have become the first choice of consumers. Companies with long-term vision will surely increase R&D investment to produce environmentally friendly products, thereby enhancing market competitiveness and staying in an invincible position in the competition. Berman and Bui (2001) investigated the productivity of the petroleum smelting industry in the Los Angeles area of the United States during the 1979-1992 government implementation of strict air pollution regulations, and found that the productivity of regulated companies increased significantly compared with unregulated companies[5].

H1: The intensity of environmental regulations is positively correlated with R&D investment.

3.2. R&D Investment Affects Corporate Financial Performance

Innovation promotes the optimization of existing products and accelerates the advent of new products, provides protection for enterprises to open up new markets and attract consumers, and at the same time promotes polluting enterprises to innovate production technology and improve resource use efficiency, thereby reducing business costs and improving financial performance. Han and Manry (2004) verified the relationship between R&D expenditure and corporate financial performance. Financial performance is measured by stock price. The study found that R&D expenditure has a positive effect on the company's stock price, that is, there is a positive relationship between the two [6]. Bartoloni E (2013) pointed out that the research and development investment of enterprises can not only improve the financial performance of enterprises at present, but also can continue to affect the financial performance of enterprises in the future [7]. Jie Maohua and Wang Yuanyuan (2011) empirically studied the relationship between R&D investment and financial performance of resource-intensive enterprises in my country by constructing a multiple linear regression model, and pointed out that R&D by enterprises can effectively increase the financial performance of enterprises, which can be reflected in the increase in the market value of enterprises [8].

H2: R&D is positively correlated with corporate financial performance.

3.3. Environmental Regulations Affect Corporate Financial Performance

Under environmental regulation policies, companies will carry out technological process, equipment and product innovations to reduce energy consumption and save resources. At the same time, it also brings a reduction in production costs and an increase in production efficiency, which in turn promotes an increase in financial performance. According to the research of McLaughlin and Klassen (1996), if the actual work of the enterprise and the environmental regulation policy implemented by the government can be perfectly combined, it can first be reflected in the reduction of production costs or the improvement of the market competitiveness of the enterprise, and then the financial performance of the enterprise can be improved, but the premise is that the environmental regulation of the government is effective and reasonable [9]. Jiang Jie and Li zuozhi (2017) used empirical analysis to test the positive correlation between environmental performance and financial performance of China's A-share manufacturing enterprises from 2011 to 2015[10].

H3: Environmental regulations are positively related to corporate financial performance.

4. Research Design

4.1. Research Variables

4.1.1. R&D Investment Intensity

R&D investment involves labor, capital, equipment, raw materials and other resources. The labor input mainly involves the salary, bonus and subsidy of scientific research personnel; Investment in equipment and raw materials can be measured by capital. Therefore, R & D investment can be measured by capital investment and labor cost. In this paper, the relative index of R&D expenditure is used to express the intensity of R&D investment.

$$\text{R\&D investment intensity} = \text{R\&D expense} / \text{revenue}$$

4.1.2. Environmental Regulation Intensity

This paper chooses the investment expenditure of environmental protection to reflect the intensity of environmental regulation. The amount of environmental investment expenditure can reflect the importance of a government to environmental protection and the response of enterprises to national environmental regulation policies. Because of the influence of the scale

of the enterprise, the environmental investment expenditure cannot be directly used in absolute numbers. Therefore, the intensity of environmental regulation is the intensity of environmental protection investment expenditure.

Environmental regulation intensity= environmental investment expenditure/ revenue.

4.1.3. ROE

Return on equity can comprehensively reflect the profitability of enterprises. Considering the requirements of financial reporting uniformity and the difficulty of data collection, return on equity is selected to evaluate the financial performance of enterprises.

$$ROE = \text{net profits} / \text{net assets}$$

4.1.4. Research Variables Table

Table 1. Research variables

Variables	Definition	Variable formula
R&D	R&D investment intensity	R&D expense/ revenue*100%
EI	Environmental regulation intensity	environmental investment expenditure/ revenue*100%
ROE	Return on equity	net profits/net assets
SIZE	Enterprise size	ln SIZE
LEV	Asset-liability ratio	debt/asset*100%
CE	Operation Efficiency	operating cost/ revenue*100%
Growth	Development capacity	Growth of operating revenue / total operating revenue of last year*100%

4.2. Model Design

This paper constructs a model (1) to verify the relationship between environmental regulation and R&D investment.

$$ROE_{i,t} = \beta_0 + \beta_1 R\&D_{i,t} + \beta_2 \ln SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 CE_{i,t} + \beta_5 Growth_{i,t} + \beta_6 Year_{i,t} + \epsilon_{i,t} \tag{1}$$

This paper constructs a model (2) to verify the relationship between R&D investment and ROE.

$$ROE_{i,t} = \beta_0 + \beta_1 R\&D_{i,t} + \beta_2 \ln SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 CE_{i,t} + \beta_5 Growth_{i,t} + \beta_6 Year_{i,t} + \epsilon_{i,t} \tag{2}$$

This paper constructs a model (3) to verify the relationship between environmental regulation and ROE.

$$ROE_{i,t} = \beta_0 + \beta_1 EI_{i,t} + \beta_2 \ln SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 CE_{i,t} + \beta_5 Growth_{i,t} + \epsilon \tag{3}$$

5. Research Results

This paper uses excel2010 and stata13 to build a linear regression model to make descriptive statistical analysis, correlation analysis and regression analysis on the relationship between environmental regulation intensity and enterprise R&D investment and financial performance.

5.1. Descriptive Statistics

Table 2. Descriptive statistics

Variable	Obs	Mean	Std.Dev.	Max	Min	Median
R&D	2214	0.0320	0.0246	0.1490	0.0003	0.0316
EI	1674	0.0019	0.0034	0.0221	0.0000	0.0009
ROE	2214	0.0578	0.1111	0.3855	-0.4339	0.0562
LnSIZE	2214	22.191	1.1865	25.281	19.883	22.096
LEV	2214	0.4360	0.1990	0.8680	0.0557	0.4290
CE	2214	0.7670	0.1520	1.0160	0.2200	0.7960
Growth	2214	0.1120	0.2740	1.3180	-0.4220	0.0751

The average value of return on equity is 5.78%, the minimum value is negative, and the maximum value is 38.55%. From the same standard deviation, there is a big difference in return on equity among the selected samples of manufacturing enterprises in China, which may be caused by the nature of enterprises and the situation of sub industries. Because some enterprises do not disclose or disclose in other projects, the observation value of environmental protection expenditure is less. The environmental protection expenditure of the indicator unit of environmental regulation business income is in the range of 0.0000 to 0.0221, with an average of 0.0019. From the average point of view, the overall environmental protection expenditure of manufacturing industry is not high, because some enterprises do not disclose or do not disclose in other projects, resulting in less observation. The average R&D investment intensity is 0.0320, and the overall R&D investment intensity is not high. This shows that China's manufacturing enterprises are not innovative enough, and we need to pay attention to the investment in this area. From the maximum value of 25.281, the minimum value of 19.883 and the standard deviation of 1.1865, the size of the selected sample companies is close, indicating that the size of the selected sample companies is evenly distributed. From the maximum value of 86.80% and the minimum value of 5.57%, we can see that the financing methods of sample companies are quite different. However, judging from the average asset liability ratio of the sample companies of 43.60%, most of the manufacturing enterprises in the sample have adopted a relatively stable development strategy. The asset liability ratio of the enterprise is not high, so the enterprise can reduce the pressure of debt repayment at any time when it carries out R&D investment, so that the enterprise can carry out R&D investment without worries; However, enterprises should also be moderately in debt and make rational use of the role of financial leverage.

5.2. Correlation Analysis

Table 3. Correlation analysis

R&D	EI	ROE	LnSIZE	LEV	CE	Growth
R&D	1					
EI	0.144***	1				
ROE	0.0300	0.058**	1			
LnSIZE	-0.278***	-0.151***	-0.0110	1		
LEV	-0.311***	-0.112***	-0.245***	0.533***	1	
CE	-0.312***	-0.136***	-0.458***	0.218***	0.421***	1
Growth	0.038*	-0.00300	0.342***	0.038*	-0.052**	-0.209***

It can be seen from the correlation coefficient table and the critical value level commonly used in the literature that the correlation coefficients between the variables are lower than the critical value, indicating that there is no serious multicollinearity in the setting of the model. The correlation coefficient of EI with R&D and ROE is significantly positive, which is in line with the expectation of this paper.

5.3. Empirical Results

Table 4. Regression analysis (a)

Variable	regression coefficient	Std.Dev.	T	P
EI	0.3886***	0.1454	2.67	0.008
lnSize	-0.0023***	0.0006	-4.10	0.000
Lev	-0.0081**	0.0032	-2.55	0.011
CE	-0.0454***	0.0047	-9.67	0.000
Growth	-0.0060***	0.0017	-3.47	0.000
_cons	0.0979***	0.0135	7.27	0.000
			F-test	14.73***
			Adj R-squared	0.4982

Table 5. Regression analysis (b)

Variable	regression coefficient	Std.Dev.	T	P
R&D	0.9734***	0.1057	9.21	0.000
lnSize	0.0111***	0.0024	4.60	0.000
Lev	-0.0667***	0.0139	-4.79	0.000
CE	-0.4691**	0.0207	-22.66	0.000
Growth	0.0808***	0.0075	10.76	0.000
_cons	0.1994***	0.0597	3.34	0.001
			F-test	13.47***
			Adj R-squared	0.4055

Table 6. Regression analysis (c)

Variable	regression coefficient	Std.Dev.	T	P
EI	0.3760***	0.6799	5.82	0.000
lnSize	0.0138***	0.0023	6.00	0.000
Lev	-0.0957***	0.0148	-6.47	0.000
CE	-0.2663***	0.0167	-15.91	0.000
Growth	0.1112***	0.0087	12.81	0.000
_cons	-0.0183	0.0496	-0.37	0.713
			F-test	10.85***
			Adj R-squared	0.3129

From the Table 4 regression results, we can see that the F-test is significantly positive after considering the time effect and industry effect, which shows that the variables selected in this paper have a significant impact on R&D on the whole, and the selection of variables is reasonable; The R² is 49.82%, which is ideal. Specifically, the regression of environmental regulation intensity to R&D intensity is significantly positive. With other conditions unchanged, every 1% increase in environmental regulation intensity will increase the R&D investment intensity by 0.3886%, which is consistent with hypothesis 1. From the perspective of control variables, enterprise scale, asset liability ratio, enterprise cost rate and operating revenue growth rate have significant negative effects on R&D.

From the Table 5 regression results, the F test is significantly positive considering the time effect and industry effect, which indicates that the variables selected in this paper have a

significant impact on ROE, and the selection of variables is reasonable; The R^2 reached 40.55%, which is ideal. Specifically, the effect of R&D on roe is significantly positive, which is consistent with hypothesis 2. In terms of control variables, asset liability ratio and enterprise cost ratio have significant negative effects on roe; The enterprise scale and the growth rate of operating revenue have a significant positive impact on ROE.

From the Table 6 regression results, the F test is significantly positive, which shows that the variables selected in this paper have a significant impact on roe on the whole, and the choice of variables is reasonable; The R^2 is 31.29%, which is ideal. Specifically, EI has a positive effect on ROE, but it is not significant. In terms of control variables, asset liability ratio and enterprise cost ratio have significant negative effects on roe; The enterprise scale and the growth rate of operating revenue have a significant positive impact on ROE.

6. Conclusion

6.1. Research Conclusions

With the increasing shortage of global resources and the worsening of environment, the extensive development mode of direct consumption of raw materials is bound to come to an end. With the advent of the industrial revolution in the Internet era characterized by green, intelligent and sustainable, the traditional heavy polluting enterprises will be gradually eliminated, and the emerging industries and market demand will emerge as the times require. This paper selects the annual data of 396 listed companies in China's A-share manufacturing industry from 2014 to 2019 as the sample, uses the previous research methods for reference, constructs a multiple linear regression model, and empirically studies the impact of R&D investment on financial performance under environmental regulation.

The following conclusions are obtained by empirical analysis:

- (1) From model 1, the intensity of environmental regulation is positive to the intensity of R&D investment. In China's manufacturing enterprises, environmental regulation can promote the innovation of science and technology, which proves to some extent the Porter hypothesis.
- (2) From model 2, the R&D investment intensity has a positive correlation with the business performance of the enterprise. From descriptive statistics, it can be concluded that the overall R&D investment intensity is low, which proves that the enterprise should increase the R&D investment to improve the financial performance.
- (3) From model 3, environmental regulation has a positive correlation with the financial performance of enterprises. Enterprises can not only obtain preferential policies of the government, reduce the fines caused by environmental pollution, but also establish the image of environmentally friendly enterprises in the market and increase the value of enterprises.

6.2. Research Suggestions

- (1) Strengthen the environmental oriented technological innovation

The results show that R&D investment intensity can significantly improve the financial performance of enterprises, and innovation is the first productivity of enterprises. Only when an enterprise continuously carries out technological innovation can it survive in today's fast-growing society.

- (2) Formulate the internal environmental management system of the enterprise

Enterprises can improve their environmental performance through the certification of environmental management system. This can not only help enterprises re-examine their own environmental management system, improve the efficiency of management, and ultimately reflect in the improvement of environmental performance.

(3) Improve the internal environment monitoring system of the enterprise

Firstly, they should improve their own environmental monitoring system, consult relevant experts to design a set of reasonable monitoring scheme for enterprise environmental protection. The second suggestion is to reduce the information asymmetry during the operation period, and establish a comprehensive information system by using Internet technology, so that shareholders and ordinary employees can obtain relevant information timely and accurately. Thirdly, the incentive and punishment mechanism for environmental protection should be established, and investors should reward operators and ordinary employees for their contributions to environmental protection. If there are managers and employees who are resistant to environmental protection and resource conservation and who waste resources and destroy the environment maliciously, they should be severely punished.

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