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An empirical study on the impact of sustainable entrepreneurship: Based on the environmental Kuznets model

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ABSTRACT

The economy and environment are closely related and inseparable. This paper attempts to reinterpret the environmental Kuznets model from an entrepreneurial perspective. Therefore, in this paper, the panel regression model is used to test the relationship between entrepreneurship, economic development and environmental pollution under micro data, and a moderated mediation model is constructed to analyze the relationship between entrepreneurship and the three environmental effects. In addition, in this paper, the environmental Kuznets curve and entrepreneurial influences under different regions, industrial properties and property rights are considered from the perspective of enterprise heterogeneity. The results show that China's listed polluting enterprises display an N-type environmental Kuznets curve. The direct effect of entrepreneurship promotes environmental pollution, but entrepreneurship exerts an adverse effect on the environment through environmental technological effects, scale effects and structural effects. At the same time, environmental regulation reverses the positive effect of the moderated effect on environmental pollution and then alleviates environmental pressure.

1. Introduction

In recent years, the rate of Chinese economic growth has slowed down. In 2018, the economic growth rate was 6.6% for the whole year, which was the lowest rate since 1990. With the changes in supply and demand in the labor market, many material resources have also encountered bottlenecks. At present, the demographic dividend is decreasing, resource constraints are increasing, economic growth momentum is obviously insufficient, environmental pollution is serious, and the ecosystem is degraded. Thus, focusing on the sustainable real economy and high-quality development has become the key. The real economy is the foundation for stable and healthy economic development. As an important part of the real economy, enterprises are the mainstay for high-quality economic development, which means that high-quality and sustainable development cannot be separated from enterprises' own sustainability contributions. In China, the contradiction between economic growth and environmental protection has become increasingly prominent and handling the relationship between economic development and environmental quality is of great significance for macroeconomic regulation and pollution control. Additionally, the value of the green market related to environmental protection in China will be close to 1 trillion dollars by 2020. In the next five years, China is expected to invest 800 billion dollars in the clean energy industry. There are two different types of companies faced with these opportunities. The traditional enterprise development model is based on the premise of sacrificing environmental resources. The increase in the enterprise's output level is accompanied by the enterprise's poor environmental performance. On the other hand, with the strengthening of corporate environmental protection awareness, far-sighted companies may seize new green market opportunities and improve the corporate energy and resource utilization efficiency by changing the existing production methods, speeding up the transformation and upgrading of corporate structures, and promoting companies. The production level is shifted from quantity-driven to quality-driven, realizing a virtuous circle of environment and economy improvement. In summary, the increase in the output levels of enterprises may increase the threat to the environment. Second, the increase in the output levels of enterprises may also relieve the pressure on the environment caused by enterprises.

The environmental Kuznets curve is often used to explain the relationship between the environment and the economy at the macro level. It is generally believed that there is a U-shaped relationship between the environment and the economy; that is, as the economy develops, the environmental quality gradually declines and then develops to a certain stage, and then the environmental quality begins to improve. Therefore,

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it is necessary to verify whether there is an inverted U-shaped environmental Kuznets curve between the output level of the enterprise and the environmental performance of the enterprise in China.

The rest of this paper is organized into six sections. Following the introduction, the second section gives the theoretical framework. The third section provides the hypotheses development. The fourth section provides the design of the empirical models and data. The empirical results and analysis are given in section five, and the conclusions are drawn in the last section.

2. Theoretical framework

The triple bottom line theory is a sustainable development theory that has emerged in recent years, which includes social value, economic value and environmental value. It is mostly used in the evaluation of corporate sustainable development and motivation analysis. Dhahri and Omri (2018) find that there is an interaction between entrepreneurship and the three pillars of a company's sustainable development in the long term or short term. The combination of the three bottom lines and entrepreneurship explains well the initiative and spontaneity of enterprises in conducting green activities, and entrepreneurs need entrepreneurship to carry out sustainable activities. In recent years, the research on entrepreneurship has attracted much attention. Among the different streams in the entrepreneurship literature, the research on sustainable entrepreneurship focuses on business activities that are likely to maintain a "sustainable" society and ecosystem. It not only seeks to realize the social value of the company but also pursues economic feasibility and environmental issues. Environmental entrepreneurship is a type of entrepreneurship that has led companies to achieve both economic and environmental benefits (Thompson, Kiefer, & York, 2011).

The relationship between entrepreneurship and the environment is a hot area in the current research. Entrepreneurs are the key figures in the development of enterprises and are the purveyors of entrepreneurship. Achieving enterprises with green and sustainable development is a task and requirement of the new era. In this process, entrepreneurship plays an important role. Entrepreneurship helps companies adapt to market changes and actively guides companies to carry out activities such as technological green innovation and foreign investment, thereby promoting their practices in environmental governance and innovation to improve the environmental quality. Many studies have explored the relationship between economic development and environmental pollution (Sarkodie & Strezov, 2018). With the increasing social requirements regarding environmental quality, the environment has become an important and scarce resource of the economy and society. Economic activities affect the environment, while environmental changes affect the economy. Liu, Wang, and Liu (2012) verified the interaction between economic growth and pollution emissions. They found that the current economic growth in China promotes pollution emissions, but pollution emissions inhibit economic growth in turn. Fan (2018) also pointed out that economic growth will exacerbate pollution emissions, and pollution emissions will promote economic growth at the same time. In the long run, the environmental quality improvements and economic growth can reach a balance, that is, they coordinate development and realize a virtuous cycle of economic growth and environmental improvement (Pan, 2005; Zhong & Jian, 2005).

Kuznets (1955) proposed the hypothesis of the relationship between income inequality and economic growth. When the economy is not fully developed, income distribution will tend to be unequal as the economy develops, and after experiencing a period of no major changes in income distribution, the income distribution will tend to become equal when the stage of full economic development is reached. Since then, environmental economists have found that the relationship described by Kuznets has a certain similarity with the relationship between the environment and the economy. Therefore, it was applied to environmental and economic problems, and they named it the environmental Kuznets curve. Most of the research on the relationship between the economy and the environment is based on the environmental Kuznets hypothesis proposed by Grossman and Krueger (1995). Selden and Song (1994), Stern, Common, and Barbier (1996), Dinda, Coomdoo, and Pal (2003), Brock and Taylor (2010), Buehn and Farzanegan (2013), Adu and Denkyirah (2017) all believed that there is an inverted U-shaped function between the amount of pollutants and the level of economic development in a country or region. The EKC hypothesis indicates that environmental quality begins to degrade with increasing income, and it improves with increasing income when the income levels rise to a certain level, which means that there is an inverted "U" relationship between environmental quality and income (Stokey, 1998). However, the relationship between the environment and the economy is unified. Nicholas and Ilhan (2015) tested the environmental Kuznets curve hypothesis of 14 Asian countries, and the results showed that there is an inverted u-shaped relationship between carbon dioxide emissions and per capita income. Culas (2007) used deforestation data, while Song, Zheng, and Tong (2008) used three industrial waste indicators (waste gas, wastewater, and waste), to measure environmental pollution, and they found the EKC effect. Shen and Xu (2000) analyzed the correlation between the per capita industrial "three wastes" and GDP per capita in Zhejiang Province and found that the environmental Kuznets curve first showed an inverted "U" shape and then showed a "U" wave shape. Sinha, Shahbaz, and Balsalobre (2017) pointed out that there is an "N" relationship between income and carbon emissions and that there are two inflection points. In addition, scholars have tried to explain the relationship between economic growth and environmental pollution from different perspectives. Grossman and Krueger (1991) believed that the relationship between economic growth and environmental quality can be explained from the following three aspects: scale effect, structure effect and technology effect. Shen (2008) found that technological progress had positive and negative effects on environmental quality changes, which caused the comprehensive environmental pollution model to be positive "U" shaped in Shanghai. On the basis of the three major environmental effects, Fu (2011) considered the policy elimination effects. He pointed out that technological and policy elimination effects can improve the environmental quality, but scale effects and structural effects are not conducive to environmental protection, which may generate an "N" type environmental Kuznets curve. In addition, Ben Youssef, Boubaker, and Omri (2018) believed that entrepreneurship is an important factor that cannot be ignored in sustainable development, and it should be incorporated into the environmental EKC model to comprehensively consider the impact of entrepreneurship on environmental performance.

The research on the environmental Kuznets curve starts from almost the macro level. This paper will use micro data to verify the existence of the environmental Kuznets curve and expand the EKC to a certain extent. This paper also explains the environmental Kuznets curve from the perspective of entrepreneurship, which enriches the relevant literature. At the same time, this paper will explore the impact of entrepreneurship on environmental performance, take environmental regulation as a moderating variable, and further analyze the relationship between entrepreneurship and three major environmental effects (the technology effect, structure effect and scale effect) by constructing a moderating mediation effect model. This empirical study will help strengthen entrepreneurs' emphasis on sustainable entrepreneurship and provide a reference for promoting the sustainable development of society.

3. Hypotheses development

The traditional theory believes that due to the inherent market failure and other characteristics of the economic system, entrepreneurship hinders companies from actively solving environmental problems and stimulates corporate behaviors that cause environmental degradation consequences (Bator, 1958; Oates, 1992; Pigou, 1932). Entrepreneurship may cause companies to sacrifice the environment for potential

economic benefits, thereby aggravating environmental damage. However, some scholars believe that entrepreneurship is a means to solve environmental problems, not a source of problems (Cohen & Winn, 2007; Dean & Mcmullen, 2007; York & Venkataraman, 2010). Entrepreneurship encourages entrepreneurs to assume corporate social and environmental responsibilities (Zhao, 2010). Entrepreneurs may also be fully aware of the developing production trends and the prospects of environmentally friendly green products and technologies and may seize opportunities and increase investment in corporate environmental protection activities to reduce pollution.

This paper measures entrepreneurship through the following two dimensions: one is the spirit of adventure and the other is the spirit of innovation. The adventurous spirit emphasizes that enterprises face challenges and are not afraid of risks in the operation and decision-making process. It is specifically manifested in the development of new markets and the re-enlargement of production capacity, and it is more likely to be driven by the operating goals and profit goals of companies. The entrepreneurial spirit of innovation encourages enterprises to invest in R&D and promotes technological innovation (Niu, 2018). Driven by the spirit of innovation, companies may be more willing to conduct research and develop green products and green technologies and may even need to make huge capital investments and face in long research and development times to further improve the environment. However, more resource consumption and pollution discharge may result from the promotion of extensive and polluting technological progress; thus, the impact of the spirit of innovation on the environment is uncertain. Based on the above theoretical analysis, hypothesis 1 is as follows:

H1. Entrepreneurship is an important factor influencing the pollution emissions of enterprises, and a risk-taking spirit promotes pollution emissions, but the spirit of innovation may have positive or negative effects on pollution emissions.

Technological effects have two-sided impacts on the environment. Innovative technologies can increase productivity, improve the efficiency of resource use, and reduce the factor input per unit output, thereby weakening the impact of production on nature and the environment. Companies can use clean technologies to replace pollution technologies, which can effectively make use of resources and then reduce pollution emissions per unit of output (Lorente & Álvarez-Herranz, 2016). Technological innovation will also promote the development of enterprises, but the rapid development of enterprises requires increased investment in resources, which may result in more energy consumption and pollution emissions. Technological innovation will lead to a reduction in the unit output resources, and resource market oversupply may reduce the actual price of resources and increase the additional demand for resources to a certain extent, which means increased pollution (Sun & Qu, 2019). If the innovation results are mainly used for the reproduction of high-pollution and high-energy-consumption products, it will increase the level of environmental pollution (Ma & Hu, 2019). In addition, the increased investment in innovation research and development will have a crowding out effect on the costs of environmental governance and environmental protection investment and will continue to damage the environment (Wang & Wang, 2016).

Entrepreneurship, especially the spirit of innovation, encourages enterprises to invest in research and development and promote technological innovation, but the direction of this technological innovation is affected by the heterogeneous spirit of innovation. Because the spirit of innovation may encourage enterprises to carry out clean green innovation activities, it may also increase the damage to the environment. Therefore, from the perspective of the mediation effect, the impact of entrepreneurship on the environment will change due to the different technical effects on the environment, and it may also produce different results due to its dual nature. Hettige, Dasgupta, and Wheeler (2000) pointed out that unless environmental regulations continue to increase, pollution will continue to increase. Environmental regulations encourage enterprises to adopt more low-energy consumption and low-emission production models, which are conducive to the research and development of green and clean technologies, thereby effectively reducing pollution emissions. According to the above theoretical analysis, hypothesis 3 is as follows:

H2. Entrepreneurship, mainly the spirit of innovation, has an influence on the technological effects, and environmental regulation regulates the mediating effect between the two.

Entrepreneurship can improve an enterprise's ability to adapt to environmental changes, strengthen its core competitiveness, innovation and control, and continuously improve its own survival and development capabilities (Kuang & Cheng, 2010). Entrepreneurship has promoted the improvement of enterprises' ability to resist risks, which is conducive for enterprises to find potential opportunities and optimize their production and investment decisions, thereby expanding their production scale and achieving their growth and expansion. The expansion of an enterprise's production scale is the so-called scale effect. When the production input of an enterprise increases, resources such as materials are used in large quantities, and the increase in output also results in more pollutant emissions (Grossman & Krueger, 1991). This means that when the production scale of an enterprise expands, its input resources and output will also increase, and the adverse environmental impact will increase. Therefore, it is generally believed that the effect of scale on environmental quality is negative (Ren & Zhu, 2017). Wang, Wang, and Yang (2017) proved empirically that environmental regulation has a certain inhibitory effect on scale effects because environmental regulations of the government can restrict the excessive expansion of economic scale to a certain extent, and it is conducive to the shift from extensive to sustainable production models. Therefore, based on the above theoretical analysis, hypothesis 2 is as follows:

H3. Entrepreneurship affects the scale effects, and environmental regulations regulate the mediation effect between the two.

In economic globalization, the competitive environment of enterprises is becoming increasingly complicated, and uncertainty is becoming increasingly high. Only by continuously promoting strategic transformation, corporate change and new competitive advantages can the company survive and develop. Entrepreneurship is the fundamental force for enterprises to promote transformation and upgrading (Mao & Wu, 2009). Entrepreneurship has strengthened the awareness of the needs of corporate transformation and has provided a basis for companies to conduct strategic transformation. Profit-oriented entrepreneurship pays more attention to financial performance and is willing to sacrifice the environment to obtain personal profits. Entrepreneurship with rich social responsibility is inclined to achieve a win–win situation of environmental protection and economic benefits. Impetuous entrepreneurship is concerned with short-term benefits. These entrepreneurs are eager to realize the benefits that are immediately available and believe that it is the safest way to increase their profits. Solid entrepreneurship is not the case. These characteristics have also been fully confirmed in Chinese entrepreneurs (Chen & Shen, 2014). In addition, environmental regulation measures are conducive to promoting the optimization and upgrading of the industrial structure and promoting the development of enterprises in a greener and cleaner direction. Therefore, hypothesis 4 is as follows:

H4. Entrepreneurship influences the structural effects, and environmental regulations provide a mediating effect between the two.

4. Data and model design

In this paper, A-share listed companies in Shanghai and Shenzhen from 2008 to 2017 are selected as the research object and the sample is addressed by the following methods. First, abnormal samples, such as samples with operating incomes less than 0, are deleted. Second, missing data samples are deleted. Third, the samples whose final statistical age is less than three years are deleted to better estimate the panel model. Fourth, the samples with extreme values are deleted. Finally, 289 companies are selected as the sample in this paper.

4.1. Variable selection

4.1.1. Dependent variables

Environmental performance ($LNEP_{it}$): Su and Wang (2015) pointed out that using the operating income discharge fees and annual increments of Chinese listed building construction enterprises as proxy variables for environmental performance can effectively reflect the environmental pollution treatment. In the context of the relatively lacking environmental information data in China, selecting this proxy variable for environmental performance is a creative solution. This indicator is not only able to fully reflect the environmental performance of enterprises but the samples are also closer to reality and are more objective than other indicators, and the sample size is sufficient (Tao, Liu, & Cheng, 2017). Therefore, this paper synthesizes all factors and uses the pollutant discharge fee levied on the enterprise to measure the pollution discharge of the enterprise. Enterprises are levied sewage charges, which means that they have a certain impact on the environment and ecology. The larger the amount of sewage charges that an enterprise is levied, the greater the environmental damage caused by the enterprise, and the worse their environmental performance is.

4.1.2. Explanatory variables

Output level (LnY_{it}): When Tang and Sun (2012) studied the microlevel environmental Kuznets curve, they used the per capita output of the company to test the relationship between pollution emissions and output. They used the ratio of the industrial added value and corporate employees. Since listed companies do not have data on industrial added value, this paper uses the data on business income to replace the industrial added value. Therefore, this paper uses the logarithm of the per capita operating income to measure the output levels of the enterprises.

Entrepreneurship (IE_{it} and BE_{it}): Gu, Qian, and Lu (2018) considered entrepreneurship from innovation entrepreneurship and business entrepreneurship perspectives. Drawing on these perspectives, this paper divides entrepreneurship into the spirit of innovation (IE_{it}) and the spirit of adventure (BE_{it}). Innovation entrepreneurship is measured by the number of patent applications of an enterprise. Using the number of patent applications submitted in a year to measure the innovation level of an enterprise may have a certain lag effect. Therefore, this paper uses the number of previous patent applications. Drawing on the practices of Xie and Chang (2017), this paper uses the asset-liability ratio deviation to measure the risk-taking spirit, that is, the absolute value of the industry asset-liability ratio minus the average asset-liability ratio of the industry.

Size effect ($Size_{it}$): The scale effect of environmental pollution means that when the industrial scale of a region or country reaches a certain amount, there will be an increase in pollutant emissions. The larger the scale of the economy, the more investment is required to engage in industrial economic activities such as production. Then, the consumption of resources will increase, so more pollution emissions are generated (Zhou & Zhang, 2014). Considering the enterprise level, this paper uses the natural logarithm of total assets to measure the size of an enterprise.

Technical effect (Rd_{it}): In the early stage of economic development, technological progress was mainly used to expand the production capacity. The expansion of the production capacity has brought about an increase in the pollution emissions. At this time, technological progress has shown a negative impact on the environment. When economic development reaches a certain stage, technological progress will develop in a greener and cleaner direction, improving the efficiency of resource use and effectively reducing pollution emissions (Ma & Hu, 2019). The proportion of R&D investment in the operating income can reflect the technological change of the enterprise to a certain extent, so this method is used to measure the technical effect.

Structural effect (Ind_{it}): At this stage, the majority of listed companies that are levied sewage charges are labor-intensive and resource-intensive sectors (thermal power, agriculture, forestry, animal husbandry, fishery, metal smelting, etc.). These industries require employees to have relatively loose academic qualifications, but with the rapid development of the economy and society, scientific and technological research and development and technological innovation have gradually evolved into the core content of enterprises' participation in competition, especially in high-tech industries (Wang, 2019). The education level reflects the technical level of the company and the requirements of the employees' education structure in production and operation (Cao, Huang, & Li, 2009). Therefore, this article uses the proportion of senior high school education or above to the total number of employees to reflect the educational structure of the employees. A higher proportion indicates that the enterprise may be developing in the knowledge-intensive and technology-intensive direction, which reflects the internal structural changes of the enterprise to a certain extent.

Environmental regulation effect (Re_{it}): This article mainly takes the strength of regional regulation as the indicator and chooses the proportion of the investment in environmental governance of each province and city to the GDP of the province to indicate the environmental regulation intensity.

4.1.3. Control variables

Material capital ($Capital_{it}$) is expressed as the logarithm of the ratio of fixed asset investment to the number of employees in the company. $Motivation_{it}$ is expressed as the natural logarithm of the total annual salary of directors, supervisors and executives. $Share_{it}$ is the first shareholding ratio of major shareholders. Operating efficiency ($Cost_{it}$) is expressed by the operating cost ratio, that is, the ratio of operating costs to total revenue.

4.2. Model establishment

Model 1 is the pollution equation, which is as follows:

$$LnEP_{it} = \alpha_0 LnY_{it} + \alpha_1 IE_{it} + \alpha_2 BE_{it} + \alpha_3 Rd_{it} + \alpha_4 Cost_{it} + \alpha_5 Share_{it} + \lambda_t + \delta_i + \varepsilon_{it}.$$

where the subscript i indicates the enterprise and t refers to the period. The dependent variable indicates the level of pollution emissions, and the independent variable indicates the output level of the enterprise. IE_{it}, BE_{it} and Rd_{it} represent innovation entrepreneurship, business entrepreneurship and technological progress, respectively. This paper adds two control variables into model 1, which are $Cost_{it}$ and $Share_{it}$. The former is operating efficiency, and the latter is the structure of shareholding. λ_t is the control term of time. δ_i is the control term of the cross section. ε_{it} is the random term, where the control variables are Cost and Share.

Many scholars have pointed out that the relationship between environmental quality and economic growth cannot be simply described by linear relations; they may have more complicated connections. Therefore, referring to the practice of Ben Youssef et al. (2018), this paper uses the environmental Kuznets model to further analyze the role of economic growth and environmental quality and adds the explanatory variable of entrepreneurship into the model. Model 2 is as follows:

$$LnEP_{it} = \alpha_0 + \alpha_1 LnY_{it} + \alpha_1 LnY_{it}^2 + \alpha_3 IE_{it} + \alpha_4 BE_{it} + \alpha_5 Rd_{it} + \alpha_6 Size_{it} + \alpha_7 Re_{it} + \alpha_8 Ind_{it} + \lambda_t + \delta_i + \varepsilon_{it}.$$

Model 2 is used to verify whether there is a U-shaped relationship

between pollution emissions and output and to reconsider the mechanism of the environmental Kuznets curve from the perspective of entrepreneurship. In this model, this paper adds four control variables, including R&D investment, enterprise size, environmental regulation and labor structure. They, reflect the technological effect, scale effect, structural effect and environmental regulation effect, respectively, which can explain the formation of the environmental Kuznets curve from the traditional perspectives, which include three major effects and the effects of environmental regulation. To further explore the impact of entrepreneurship on the environmental Kuznets curve, this paper also extends model 2 by adding the cubic term of per capita output and the interaction term between entrepreneurship and the highest term of per capita business income. Then, model 3 and model 4 are obtained as follows.

Model 3:

$$LnEP_{it} = \alpha_0 + \alpha_1 LnY_{it} + \alpha_1 LnY_{it}^2 + \alpha_3 LnY_{it}^3 + \alpha_4 IE_{it} + \alpha_4 BE_{it} + \alpha_6 Rd_{it} + \alpha_7 Size_{it} + \alpha_8 Re_{it} + \alpha_9 Ind_{it} + \lambda_t + \delta_i + \varepsilon_{it}.$$

Model 4:

$$LnEP_{it} = \alpha_0 + \alpha_1 LnY_{it} + \alpha_1 LnY_{it}^2 + \alpha_3 LnY_{it}^3 + \alpha_4 IE_{it} + \alpha_4 BE_{it} + \alpha_6 Rd_{it} + \alpha_7 Size_{it} + \alpha_8 Re_{it} + \alpha_9 Ind_{it} + \alpha_{10} LnY_{it}^3 \times IE_{it} + \alpha_{11} LnY_{it}^3 \times BE_{it} + \lambda_t + \delta_i + \varepsilon_{it}.$$

5. Empirical analysis and results

5.1. Descriptive statistical analysis

According to descriptive statistical results, the mean of business entrepreneurship and the labor force structure are both slightly larger than the median. Therefore, the distribution is slightly to the right, which indicates that there are certain differences in the spirit of adventure and the structure of the labor force of the company, but the differences are not large. There are competitive differences between the mean and median of innovation entrepreneurship and R&D investment, which indicates that there is a significant difference in the investment and performance of the enterprise to carry out innovative activities (See Table 1).

5.2. Correlation analysis

According to the calculation results of the Pearson correlation coefficient, the environmental performance of a company has a significant correlation with the per capita operating income, entrepreneurship, enterprise size, R&D investment and labor force structure. The correlation level is less than 0.56, so multicollinearity does not exist. Although the correlation between environmental regulation and corporate environmental performance is not significant, according to related economics theories and existing scholars' research on the relationship between the two (Ji, Zhang, & Ren, 2019; Qian, Gao, & Huang, 2019; Sun & Qu, 2019), this paper regards environmental regulation as an important variable for studying the relationship of corporate environmental performance, entrepreneurship and corporate development. Therefore, it cannot be easily abandoned and is still included in models.

5.3. Panel regression analysis

Table 2 shows the results of model 1, where column 1 shows the estimated results of the environmental pollution equation. The coefficients of per capita output are significantly positive at the level of 1%. This indicates that an increase in enterprise output causes the enterprises to produce more pollution, which shows that pollution for growth is common among Chinese listed polluting companies. From the perspective of costs and benefits, increasing pollution emissions can bring benefits for enterprises. However, these benefits are largely greater than the cost of increasing pollution and the potential benefit of reducing pollution emissions. Therefore, enterprises tend to make decisions that are not conducive to protecting the environment. Enterprises' internal awareness of environmental protection is weak. Enterprises lack a sense of social responsibility and do not have a strong ability to control pollution. Enterprises follow a development path of "polluting first, then treating". Therefore, this development path may cause economic growth to worsen environmental degradation and further promote economic growth (Fan, 2018). The coefficients of innovation entrepreneurship and business entrepreneurship are positive and significant at the 1% and 5% levels, respectively. These results show that entrepreneurship increases environmental pollution. This is because entrepreneurship does not play a positive role among Chinese listed polluting enterprises. The coefficients of the control variables are all significant. Specifically, the coefficient of the largest shareholder's shareholding ratio is significantly positive at the 1% level. It shows that the more concentrated the equity of the company, the more likely managers are to harm the public interest for private benefits, and small and medium shareholders have a serious lack of motivation to supervise management actions. Thus, enterprises are unwilling to assume social

Table 2
The results of model 3.

Variables	$LNEP_{it}$	$LNEP_{it}$
LnY_{it}	0.037*	0.040**
	(2.270)	(2.32)
IE_{it}	0.092***	0.082**
	(3.430)	(2.89)
BE_{it}	0.012**	0.012**
	(2.78)	(2.800)
Rd_{it}	0.104**	0.107**
	(3.350)	(3.330)
$Cost_{it}$	−0.063***	−0.063***
	(−7.930)	(−7.890)
$Share_{it}$	0.057***	0.055***
	(3.480)	(3.570)

Note: The t value is bracketed, and ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 1
Results of the descriptive statistical analysis and Pearson correlation coefficient.

Variables	Results of the descriptive statistical analysis					Pearson correlation coefficient							
	Mean	*Std*	*Min*	*Max*	*Med*	*LNEP*	*LNY*	*IE*	*BE*	*Re*	*Size*	*Rd*	*Ind*
LNEP	14.565	1.834	5.832	15.962	14.748	1							
LNY	13.632	0.889	9.106	18.686	13.549	0.287***	1						
IE	28.24	0.14	0	725	7	0.174***	0.166***	1					
BE	0.217	1.176	0.001	3.565	0.18	−0.055**	−0.016	−0.063***	1				
Re	0.014	0.007	0.003	0.042	0.013	0.007	0.003	−0.03	0.023	1			
Size	22.406	1.263	18.38	26.272	22.295	0.558***	0.460***	0.389***	−0.017	0.104***	1		
Rd	0.016	0.019	0	0.1626	0.008	−0.089***	−0.100**	0.189***	−0.044*	−0.163***	−0.119***	1	
Ind	0.424	0.243	0	0.998	0.388	0.051**	0.185***	0.166***	−0.067***	−0.031	0.179***	0.075***	1

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

responsibility, and their environmental performance is poor (Liao & Yan, 2015). The coefficient of operating efficiency is −0.063, which is negatively significant at the 1% level. This shows that better operating efficiency is beneficial to environmental protection. This paper will further analyze enterprises with different property rights in the analysis of heterogeneity.

Table 3 shows the regression results of the extended environmental Kuznets model. Grossman and Krueger (1991) pointed out that technical effects, scale effects and structural effects are important factors in explaining the environmental Kuznets curve. Combined with the impact of the three effects on pollution emissions, this paper discusses these effects from the perspective of entrepreneurship. Comparing column 1 and column 2, the coefficient of the cubic term of per capita operating income is significant at the level of 5%, and the significance of the quadratic term coefficient is changed from the original at the level of 5% to the level of 1%. This shows that it is reasonable to add the cubic term into the model. Therefore, N-shaped or inverted N-shaped environmental Kuznets curves exist, which are composed of an inverted U-shaped curve and a U-shaped curve.

This shows that the production mode of exchanging pollution for growth is unavoidable in the early stage of economic development. If enterprises want to produce and develop, they will inevitably produce pollution emissions. At this time, negative environmental effects dominate. That is, the effects of technology, scale and entrepreneurship are greater than the structural effects. In the declining stage of the environmental Kuznets curve, the positive impact of the structural effect is dominant. When the output level of the enterprise reaches a certain level, the poor environmental performance of the enterprise restricts the development of the enterprise, and the environmental awareness of the enterprise is strengthened (Zhao & Zhao, 2019). At the same time, the enterprise actively promotes the transformation of its industrial structure. Then, with the increase in the output level of enterprises, the pollution emissions of the enterprises showed a gradual decline.

At this stage, there may be new growth points in the development of enterprises. By developing environmental protection industries, the enterprises are not only able to promote output growth but can also effectively control and prevent pollution and achieve a win–win situation for development and environmental improvement. This also explains why the environmental Kuznets curve will show an improvement in environmental quality with economic development after reaching the inflection point (Sun & Sun, 2017). However, from the image, the curve of this stage has a smaller decline and a shorter width, which indicates that the company has insufficient contributions in terms of environmental governance and industrial upgrading. The weak environmental regulation also results in a smaller effect of eliminating environmental pollution and has a shorter duration. Immediately afterwards, the company carries out a new round of development and growth and then returns to the previous model of pollution for growth. At this time, the effects of technology, scale and entrepreneurship are greater than the structural effects.

Table 3
Regression results of the extended EKC models.

Variables	$LNEP_{it}$	$LNEP_{it}$	$LNEP_{it}$	$LNEP_{it}$	$LNEP_{it}$
LnY_{it}	0.013	−0.024	−0.030	−0.024	−0.030
	(0.490)	(−0.660)	(−0.870)	(−0.660)	(−0.840)
LnY_{it}^2	−0.012**	−0.016***	−0.010	−0.016***	−0.010*
	(−3.010)	(−4.630)	(−1.530)	(−4.990)	(−2.100)
LnY_{it}^3		0.004**	0.006***	0.005**	0.006***
		(2.830)	(4.990)	(2.760)	(4.910)
IE_{it}	0.062***	0.061***	0.062***	0.052**	0.055***
	(3.440)	(3.450)	(3.590)	(3.210)	(3.590)
BE_{it}	0.014**	0.014**	0.014**	0.014**	0.014**
	(2.890)	(2.820)	(2.830)	(2.810)	(2.840)
Ind_{it}	−0.036**	−0.036**	−0.037**	−0.038**	−0.039**
	(−2.710)	(−2.670)	(−2.640)	(−2.930)	(−2.880)
$Size_{it}$	0.192***	0.200***	0.200***	0.197***	0.198***
	(4.680)	(4.610)	(4.690)	(4.480)	(4.490)
Rd_{it}	0.067**	0.068**	0.069**	0.069**	0.070**
	(2.620)	(2.590)	(2.600)	(2.570)	(2.580)
Re_{it}	−0.011	−0.010	−0.010	−0.011	−0.011
	(−0.880)	(−0.780)	(−0.780)	(−0.860)	(−0.850)
$IE_{it}*LnY_{it}^3$			−0.001*		−0.002**
			(−2.210)		(−2.870)
$BE_{it}*LnY_{it}^3$			0.002		0.001
			(1.330)		(1.140)
R-square	0.0666	0.0693	0.0702	0.0680	0.0691

Note: The t value is bracketed, and ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Continue to analyze the results of column 2. The coefficients of business entrepreneurship and innovation entrepreneurship are both significantly positive, which indicates that entrepreneurship has a positive impact on the environmental performance of the enterprise. The specific result is that entrepreneurship promotes pollution emissions of the enterprise. This is consistent with hypothesis 1, i.e., that business entrepreneurship and innovation entrepreneurship promote environmental pollution. The coefficient of the environmental structural effect is significantly negative at the level of 5%, which indicates that the structural upgrade of the enterprise has eased the environmental pressure and reduced the pollution emissions. The scale effect is significantly positive at the level of 1%, which indicates that the larger the production scale of the enterprise, the higher the pressure on the environment. This result is consistent with the conclusions drawn by most scholars using macro data. The coefficient of the technical effects is significantly positive at the level of 5%. This result is consistent with the research results of Ma and Hu (2019) at the macro level. They point out that the insufficient use of clean technology within the company is an important cause of increasing environmental pollution.

To further explore the relationship between entrepreneurship, enterprises' pollution emissions and per capita output, the interaction coefficient of innovation entrepreneurship and the cubic term of the per capita business income is significantly negative at the 10% level in column 3. That is, a negative moderation effect exists between innovation entrepreneurship and the cubic term of per capita operating income. Therefore, the environmental Kuznets curve moves to the lower right as a whole, and it shows a more gradual trend. This shows that due to the positive effect of entrepreneurship on the environmental quality, enterprises have reduced their pollution emissions at the original output level. It also reflects the two sides of entrepreneurship from the side that entrepreneurship has both a negative impact on environmental pollution and a positive impact on environmental improvement. This is consistent with Hypothesis 1, i.e., that the impact of innovation entrepreneurship on environmental pollution may be positive or negative.

5.4. Mechanism inspection of entrepreneurship affecting enterprise pollution emissions

This paper further explores whether entrepreneurship affects the environment through other channels, and it mainly studies whether there is a mediating relationship between entrepreneurship and the three effects. To simplify the mediation effect model, variables such as per capita income and its multiple terms are not added in the models. Only the three major effects, entrepreneurship and environmental regulation are considered. Although the regression results indicate that the effect of environmental regulation does not seem to have an impact on the environment, Wang et al. (2017) found that environmental regulation has a positive effect on the structural and technical effects and has a negative effect on the scale effect when they explored the relationship between environmental regulation and the three major effects. Therefore, drawing on the method of Wen and Ye (2014), this paper establishes a moderated mediation effect model and uses the stepwise regression method to test. Environmental regulation is a moderating variable, and the three major effects are mediated variables. Model 5 is as follows:

$$LnEP_{it} = \beta_0 + \beta_1 IE_{it} + \beta_2 BE_{it} + \beta_3 Re_{it} + \beta_4 X_{it} + \lambda_t + \delta_i + \varepsilon_{it}. \quad (1)$$

$$RD_{it} = \eta_0 + \eta_1 IE_{it} + \eta_2 BE_{it} + \eta_3 Re_{it} + \eta_4 X_{it} + \lambda_t + \delta_i + \varepsilon_{it}. \quad (2)$$

$$LnEP_{it} = \theta_0 + \theta_1 IE_{it} + \theta_2 BE_{it} + \theta_3 Re_{it} + \theta_4 RD_{it} + \theta_5 X_{it} + \lambda_t + \delta_i + \varepsilon_{it}. \quad (3)$$

$$LnEP_{it} = \lambda_0 + \lambda_1 IE_{it} + \lambda_2 BE_{it} + \lambda_3 Re_{it} + \lambda_4 RD_{it} + \lambda_5 RD_{it} \times Re_{it} + \lambda_6 X_{it} + \lambda_t + \delta_i + \varepsilon_{it}. \quad (4)$$

Eqs. (1)–(4) examine the effect of entrepreneurship on technological innovation. X represents the control variables involved in this model regression, specifically the age of the company, the shareholding of the *largest shareholder* and the debt to asset ratio. λ_t is the individual fixed effect, and δ_i is the time effect. ε_t is the random term. When studying the possible changes in scale and structure caused by the entrepreneurial spirit, only the variables of technological innovation need to be replaced by the other two variables, which are the structural effect and environmental regulation, and the rest remain unchanged.

The first part of Table 4 shows the regression results using technical effects as the mediating variable. Column 1 is the basic model, reporting the direct impact of entrepreneurship on the environmental quality, which is consistent with the research results obtained by using the EKC model. That is, entrepreneurship causes pollution to the environment. Column 2 verifies whether entrepreneurship affects the technical effects of environmental quality. The coefficient of innovation entrepreneurship is significantly positive at the level of 1%, which indicates that innovation entrepreneurship encourages technological innovation. At the same time, the spirit of adventure entrepreneurship has no obvious effect on the technical effect. The entrepreneurship spillover theory emphasizes that entrepreneurship has spillover effects and improves the capabilities of corporate research and development through the continuous accumulation of knowledge and experience, thereby promoting technological progress. In addition, innovation entrepreneurship is more closely related to corporate R&D activities. Both product innovation and technology innovation are the embodiment of the spirit of innovation. The adventurous spirit is more about the strategic decision-making and implementation of the enterprise. Therefore, the spirit of innovation plays a more obvious role in corporate R&D investment. The results in column 3 also show that the technical effect has a negative impact on environmental quality (we have obtained consistent results in Table 2), and the technical effect has promoted the discharge of environmental pollution.

According to the regression results in columns 1, 2, and 3, entrepreneurship aggravates the environmental damage caused by enterprises through the mediation effect of technological effects. Although entrepreneurship has improved the level of technological research, technological effects have a negative impact on environmental quality. Because the technology of environmental protection often requires huge investments and causes short-term profit pressure, most companies give up the initial intention to commit to energy-efficient production. That is, entrepreneurship is more likely to promote technological innovation that is applied in high pollution and high energy consumption production. The cross-term coefficient of environmental regulation and technical effects in column 4 is significantly negative at the level of 5%. This result shows that environmental regulation has a negative moderation effect on the influence of technical effects on pollution emissions. This means that environmental regulations may lead companies to carry out technological innovation in a more environmentally friendly and energy-saving direction and apply them to their production activities, thereby reducing pollution.

The second part of Table 4 shows the regression results using structural effects as the mediating mechanism. Column 2 analyzes the impact of entrepreneurship on the structural effects. The coefficients of adventurous spirit and innovative spirit are both significantly negative at the level of 5%, which indicates that entrepreneurship is not conducive to the upgrading of the corporate structure. Cheap labor is still a key competitive advantage for most companies. Because there is a lack of a good environment to cultivate entrepreneurship, in most cases, the bad side of entrepreneurship is shown. At present, there are still many impetuous, benefit-oriented and short-sighted entrepreneurs, which are not conducive to the upgrading and transformation of corporate structures. The structural effect in column 3 is significantly negative at the level of 5%. Entrepreneurship exacerbates the threat to the ecological environment through the mediation effect of the structural effect. The cross-term coefficients of environmental regulation and technical effect in column 4 are not significant. That is, environmental regulation has no moderation effect on the structural effects.

The third part of Table 4 shows the regression results using scale effects as the mediating mechanism. Column 2 analyzes the impact of entrepreneurship on the scale effect of enterprises. The coefficient of innovation entrepreneurship is significantly positive at the level of 1%, and the coefficient of adventurous spirit is significantly negative at the

Table 4
Regression results of the mediation effect.

Variables	Technical effects as a mediating variable				Structural effects as a mediating variable				Scale effects as a mediating variable			
	*LNEP*it	*R*dit	*LNEP*it	*LNEP*it	*LNEP*it	*Ind*it	*LNEP*it	*LNEP*it	*LNEP*it	*Size*it	*LNEP*it	*LNEP*it
*R*dit			0.066**	0.065**	————				————			
			(2.46)	(2.57)								
*Ind*it	————						−0.043**	−0.042**	————			
							(−3.240)	(−2.850)				
*Size*it	————				————						0.191***	0.185***
											(4.51)	(4.73)
*IE*it	0.080***	0.085***	0.074***	0.074***	0.048***	−0.038**	0.078**	0.078**	0.080***	0.084***	0.064***	0.060***
	(3.53)	(5.44)	(3.65)	(3.83)	(3.53)	(−2.340)	(3.11)	(3.17)	(3.53)	(7.25)	(3.64)	(3.51)
*BE*it	0.015**	0.016	0.014**	0.014***	0.015**	−0.029**	0.015***	0.015***	0.015**	−0.005***	0.016***	0.016***
	(3.3)	(1.56)	(3.15)	(3.46)	(3.3)	(−2.940)	(3.36)	(3.36)	(3.3)	(−4.300)	(3.42)	(3.56)
*Re*it	−0.015	0.042***	−0.018	−0.022**	−0.015	−0.01	−0.013	−0.014	−0.015	0.013*	−0.018	−0.012
	(−1.180)	(3.62)	(−1.400)	(−2.060)	(−1.180)	(−0.640)	(−1.140)	(−1.200)	(−1.180)	(2)	(−1.510)	(−1.340)
*Year*it	0.135***	0.338***	0.113***	0.049***	0.135***	0.170***	0.144***	0.048***	0.135***	0.413***	0.056**	0.038**
	(11.28)	(29.79)	(6.28)	(3.66)	(11.28)	(8.13)	(10.41)	(3.54)	(11.28)	(25.88)	(3.23)	(3.11)
*Lev*it	0.048***	−0.01	0.049***	0.080***	0.048***	0.02	0.048***	0.077***	0.048***	0.056***	0.037**	0.042**
	(3.48)	(−0.370)	(3.53)	(5.15)	(3.48)	(0.77)	(3.55)	(4.59)	(3.48)	(3.45)	(3.01)	(2.31)
*Share*it	0.080***	0.014	0.079***	0.112***	0.080***	−0.035	0.076***	0.145***	0.080***	0.206***	0.041**	0.056***
	(5.2)	(0.93)	(5.24)	(6.54)	(5.2)	(−0.870)	(4.57)	(10.55)	(5.2)	(9.54)	(2.35)	(3.45)
*Re*it* Mediating variable	*Re*it*Rdit			−0.030**	*Re*it*Indit			0.003	*Re*it*Sizeit			−0.046***
				(−3.240)				(0.22)				(−4.180)
R-square	0.0447	0.1682	0.0501	0.0524	0.0447	0.0298	0.0471	0.0472	0.0447	0.3757	0.0608	0.0659

Note: The t value is bracketed, and ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

level of 1%. These results indicate that innovation entrepreneurship promotes the scale of enterprises, while the spirit of adventure is opposite. Overall, entrepreneurship promotes the growth of the corporate scale. In column 3, the impact of scale effects is significantly positive at the level of 1%. Entrepreneurship increases the pollution emissions of enterprises through the mediation effect of the scale effect. This shows that entrepreneurship enterprises are more concerned with their own development, such as higher profits and larger enterprise scales, rather than their external performance, such as their contributions to society and nature. This is also an obvious deficiency in the current development of entrepreneurship. In column 4, the cross-term coefficient of environmental regulation and scale effect is significantly negative at the level of 1%. This result shows that the scale effect negatively moderates the positive effect of environmental regulation on pollution emissions. This means that strict environmental regulations restrict the development of enterprises to a certain extent, avoid the excessive expansion of enterprises, and enable enterprises to make more rational decisions for production and, therefore, reduce pollution emissions.

5.5. Endogeneity test

Considering the *two-way causality* between the environment and the economy, this paper adds the economical equation to form simultaneous environmental and economical equations. The economic equation of model 6 is as follows.

Model 6:

$$LnY_{it} = b_0 LnEP_{it} + b_1 IE_{it} + b_2 BE_{it} + b_3 Rd_{it} + b_4 Motivation_{it} + b_5 Capital_{it} + b_6 Year_{it} + \lambda_t + \delta_i + \varepsilon_{it}$$

Constructing the environmental and economic equation system model by combining the economic equation in model 6 with those of model 1, model 2, model 3 and model 4, this paper uses the 2SLS method and standard error of robustness to estimate. Table 5 reports the results. According to these results, the statistics of the endogeneity test are 0.540, 0.04, 1.444, and 0.912, respectively, and the p-values are 0.463, 0.837, 0.2295, and 0.3395, respectively. Thus, no endogeneity relationship exists between environmental pollution and the economy in the empirical analysis.

The important explanatory variables in the panel regression models (entrepreneurship, per capita operating income, and multiple terms) use a lagging period of indicators, which can largely avoid the reverse causality between the dependent and explanatory variables. That is, to some extent, the endogeneity problem of reverse causality between the corporate per capita output and pollution emissions can be solved. This paper uses a two-way fixed effect model with individual fixed and time fixed effects when estimating a single model. Compared with the mixed multiple regression model, the fixed effect model (FE) can control the endogeneity problems caused by unobservable individual effects at the company level. Therefore, in this paper, these models are considered to be theoretically negligible in terms of endogeneity due to reverse causality and unobservable individual effects, so we do not address the models further.

5.6. Robustness test

The spirit of innovation uses different metrics for the key variable. Due to the time lag between patent grants and patent applications, i.e., the patent application generally precedes the grant, this paper uses the current number of patent grants to replace the innovative spirit to obtain the robustness test of the model. The last column of Table 2 and the last two columns of Table 3 are the regression results after replacing the variables. Compared with the relevant data, it can be found that there is basically no difference in the estimated results of the models before replacement and after replacement. Table 6 is the mediation effect model after replacing the variables. The estimated results of the control variables (asset-liability ratio, the largest shareholder ratio, and the age of the company) have not been shown due to layout restrictions. When comparing the estimated results of the mediation effect model before replacement, there is no obvious inconsistency in either the significance of the coefficients or the sign of the coefficients.

Table 5
The results of 2SLS.

Pollution equation	Model 1	Model 2	Model 3	Model 4
Endogeneity test of endogenous regressors	0.540 (0.463)	0.042 (0.837)	1.444 (0.230)	0.912 (0.340)

5.7. Heterogeneity analysis of enterprises

This paper has explored the shape of the environmental Kuznets curve and the relationship between entrepreneurship and the environment. However, this connection will be affected by various factors, and heterogeneity is observed in different enterprises. It is generally believed that the environmental performance of enterprises in heavily polluting industries and that in industries that do not pollute heavily are quite different. Zhang and Li (2018) pointed out that, compared with state-owned enterprises, private enterprises always seek to maximize the wealth of shareholders, and they pay more attention to the balance between costs and benefits in their environmental behaviors. Zang and Lv (2016) pointed out that there are regional differences between the level of environmental pollution and economic development in eastern, central and western China. Therefore, this paper next considers the impact of heterogeneity and further studies whether there are different environmental Kuznets curves and different influences of entrepreneurship on different industry properties, property rights and geographical locations.

5.7.1. Industry property analysis

In this section, the shape of the environmental Kuznets curve and its connection with entrepreneurship in the key and non-key polluting industries are compared. The first part of Table 7 gives the regression results of the key and non-key polluting industries. According to these results, there is an N-type environmental Kuznets curve in the non-key polluting industries. That is, the coefficient of the square term of per capita operating income is significantly negative, and the coefficient of the cubic term is significantly positive. In addition, the coefficients of entrepreneurship, technical effects, structural effects, and environmental regulation effects are not significant. The coefficient of the scale effect is significantly positive at the level of 5%. At this time, the scale effect of the environment is observed, and other effects are not observed. We think this N-type environmental Kuznets curve may be caused by the interaction effects of other factors and the scale effect. When analyzing the results of the key polluting industries, it is found that there is a special N-type that has no obvious stage of decline. In the regression results of column 3, only the cubic term of per capita income is significantly positive at the level of 1%. Therefore, the environmental Kuznets curve is a curve in which pollution emissions first increase slowly and then rapidly as the output levels increase. The coefficient of entrepreneurship is not significant (at the 5% level). The coefficient of the scale effect of the environment is negative, the technical effect is negative, and the structural effect is positive.

The above results show that the key polluting industries always use pollution to obtain output growth. Initially, the enterprises are in the initial stage of development. With the development of their technologies, their production is on track. Although the pollution has continued to increase, the growth rate slows down when their scale and output reach the saturation point. Enterprises can increase output only by continuously consuming a large amount of resources, and the negative effect on the environment from beginning to end is always larger than the positive effect on the environment. We have noticed that in both the

Table 6
Regression results of the mediating effect model after replacing the variables.

Variables	Technical effects				Structural effects				Scale effects			
	*LNEP*it	*Rd*it	*LNEP*it	*LNEP*it	*LNEP*it	*Ind*it	*LNEP*it	*LNEP*it	*LNEP*it	*Size*it	*LNEP*it	*LNEP*it
*Rd*it			0.067** (2.42)	0.067** (2.53)	———				———			
*Ind*it	———						−0.045*** (−3.660)	−0.044** (−3.170)	———			
*Size*it	———				———						0.191*** (4.45)	0.185*** (4.7)
*IE*it	0.071** (3.53)	0.071** (3.17)	0.072*** (3.55)	0.074*** (3.71)	0.071** (3.53)	−0.004 (−0.130)	0.072** (2.84)	0.072** (2.87)	0.071** (3.53)	0.010*** (7.27)	0.058*** (3.48)	0.053** (3.1)
*BE*it	0.015** (3.3)	0.016 (1.6)	0.014** (3.22)	0.015*** (3.57)	0.015** (3.3)	−0.028** (−2.870)	0.015*** (3.41)	0.015*** (3.4)	0.015** (3.3)	−0.004*** (−4.130)	0.016*** (3.44)	0.016*** (3.58)
*Re*it	−0.016 (−1.290)	0.041** (3.3)	−0.019 (−1.400)	−0.023* (−2.280)	−0.016 (−1.290)	−0.01 (−0.620)	−0.014 (−1.250)	−0.014 (−1.130)	−0.016 (−1.290)	0.013* (2.04)	−0.018 (−1.600)	−0.012 (−1.510)
*Re*it*Mediating variables	$Re_{it}*Rd_{it}$			−0.032*** (−3.610)	$Re_{it}*Ind_{it}$			0.004 (0.25)	$Re_{it}*Size_{it}$			−0.046*** (−4.130)

Note: The t value is bracketed, and ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

non-key polluting industries and key polluting industries, entrepreneurship has no impact on the environmental quality, which may be related to the internal and external governance of the environment. Li, Su, and Dong (2006) proposed that in the environment of corporate governance, there are two mutually opposing mechanisms, i.e., entrepreneurship inspiration and health care. Good corporate governance can fully stimulate and play the role of entrepreneurship. The cross-term coefficient of the spirit of innovation and per capita income in column 2 is significant at the level of 5%, while the spirit of innovation is not significant in column 1. These results indicate that the output of the enterprise has stimulated entrepreneurship to a certain extent, which promotes green and cleaner production and reduces pollution emissions. The coefficient of the cross-term of the spirit of adventure and per capita income in column 4 is significantly positive at the level of 5%, which indicates that the output of the enterprise stimulates the entrepreneurial spirit of adventure and increases the pollution emissions of the enterprise. This may be because the key polluting industries may rely more on high-polluting, high-energy production methods to develop enterprises, so the spirit of adventure further pollutes the environment by affecting output.

5.7.2. *Geographical factor analysis*

Considering the different geographical locations of enterprises, this paper explores the differences between eastern and western enterprises. The second part of Table 7 reports the regression results of eastern and western industries. According to columns 1 and 2 of this part of Table 7, the quadratic coefficients of the output are significantly negative. This shows that there is an inverted U-shaped environmental Kuznets curve in eastern enterprises. The coefficient of the spirit of innovation is not significant, which reflects that innovation entrepreneurship may have a positive impact on the environment. However, due to various factors, entrepreneurship cannot take place while improving environmental quality. The spirit of adventure is significantly positive. This shows that adventurous entrepreneurship is still an important factor in encouraging the pollution behavior of enterprises. However, the technical effects, structural effects and scale effects have no significant effect on the environmental performance of enterprises. The eastern region is in a leading position in terms of economic development, technological innovation and the awareness of corporate environmental protection. Zhou (2011) pointed out that the scale effect of the environment is usually reflected in the initial stage of economic development. When economic development reaches a certain stage, scale effects do not always take place. In the eastern region, most enterprises have achieved steady growth due to the high level of economic development. Therefore, the scale effects may show no impact. He (2016) showed that the industry in the eastern region has entered the stage of high-end manufacturing and clean production; the tertiary industry is developing rapidly, and it is the first to enter the stage of optimizing the industrial structure and greatly reducing the pollution emissions of enterprises. We have reasons to believe that in the east, the contribution of the corporate structure upgrades to reducing pollution emissions is gradually weakening or disappearing. Technological effects are also losing their influence on the environment.

Combining the results of columns 3 and 4 in this part, the environmental Kuznets curve in the western region should indicate that the pollution emissions increase slowly and then rapidly as the output levels increase. In the western region, the level of economic development is lagging behind, and the regional economy mainly relies on the high energy-consuming and highly polluting secondary industry. The primary task of enterprises is development, and environmental issues are often overlooked. Entrepreneurship (innovation entrepreneurship), technical effects and scale effects are still the causes of pollution. The structural effects alleviate environmental problems. In addition, the cross terms of innovation entrepreneurship and the square and cubic terms of per capita operating income in columns 2 and 4 are significantly negative. This result indicates that there is a positive effect of

Table 7
Results of the models for heterogeneity analysis.

Variables	Industry properties				Geographical factor				Property rights structure factors			
	Non-key polluting companies		Key polluting companies		East		West		SOE		Non-SOE	
	*LNEP*it	*LNEP*it	*LNEP*it	*LNEP*it	*LNEP*it	*LNEP*it	*LNEP*it	*LNEP*it	*LNEP*it	*LNEP*it	*LNEP*it	*LNEP*it
*LnY*it	−0.086	−0.092	−0.026	−0.023	0.016	0.016	−0.021	−0.033	0.061	−0.068*	0.376	———
	(−1.190)	(−1.330)	(−0.820)	(−0.710)	(0.45)	(0.45)	(−0.530)	(−0.880)	(−1.770)	(−2.190)	(0.87)	
*LnY*it2	−0.068**	−0.063**	−0.005	−0.004	−0.041***	−0.074***	−0.013**	−0.008	−0.024***	−0.017**		———
	(−3.050)	(−2.740)	(−1.160)	(−0.890)	(−5.220)	(−5.210)	(−2.630)	(−1.180)	(−4.710)	(−2.530)		
*LnY*it3	0.014**	0.018***	0.006***	0.005**			0.004	0.006***	0.006***	0.008***		———
	(2.45)	(3.61)	(3.86)	(3.06)			(1.79)	(4.12)	(3.59)	(5.63)		
*IE*it	0.042	0.044*	0.05	0.05	−0.022	0.026	0.058***	0.060***	0.027	0.029	0.098***	———
	(1.78)	(1.95)	(1.85)	(1.71)	(−0.610)	(0.76)	(3.35)	(3.45)	(1.27)	(1.43)	(4.56)	
*BE*it	0.006	0.006	0.017*	0.017*	0.034***	0.044**	−0.011	−0.011	0.018***	0.018***	0.012	———
	(0.45)	(0.46)	(2.05)	(2.09)	(3.74)	(2.61)	(−0.940)	(−0.940)	(3.41)	(3.38)	(0.63)	
*Ind*it	−0.048	−0.049	−0.048***	−0.048***	−0.053	−0.051	−0.034**	−0.036**	−0.006	−0.006	−0.082*	———
	(−1.640)	(−1.670)	(−7.210)	(−7.410)	(−1.000)	(−0.950)	(−2.370)	(−2.550)	(−0.870)	(−0.930)	(−2.180)	
*Size*it	0.243**	0.241**	0.170***	0.170***	0.047	0.045	0.247***	0.250***	0.272***	0.274***	0.177**	———
	(2.85)	(2.82)	(6.61)	(6.8)	(0.69)	(0.68)	(5.7)	(5.71)	(5.57)	(5.56)	(2.81)	
*Rd*it	0.068	0.069*	0.073***	0.073***	0.006	0.003	0.088***	0.089***	0.096***	0.097***	−0.01	———
	(1.85)	(1.87)	(2.44)	(2.45)	(0.12)	(0.06)	(3.91)	(3.99)	(4.46)	(4.51)	(−0.200)	
*Re*it	−0.04	−0.041	0.008	0.008	−0.019	−0.022	0.002	0.002	0.002	0.002	0.004	———
	(−1.780)	(−1.770)	(0.58)	(0.57)	(−0.530)	(−0.620)	(0.17)	(0.13)	(0.26)	(0.27)	(0.15)	
*IE*it*LnYit2						−0.096***						
						(−3.280)						
*BE*it*LnYit2						−0.011						
						(−0.830)						
*IE*it*LnYit3		−0.003**		0				−0.002**		−0.001**		———
		(−2.840)		(0.25)				(−2.660)		(−2.960)		
*BE*it*LnYit3		0		0.003**				0.002		0.001		———
		(−0.060)		(2.49)				(1.18)		(0.38)		
R-square	0.1407	0.1432	0.0563	0.0567	0.06	0.0636	0.0868	0.0881	0.1082	0.1091	0.0646	———

Note: The t value is bracketed, and ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

entrepreneurship on the environment in both the east and the west, and the east has a stronger performance. This is related to the higher level of innovation of eastern enterprises and the greater emphasis on environmental protection.

5.7.3. Property rights structure factors analysis

The third part of Table 7 analyzes the differences between state-owned enterprises and nonstate-owned enterprises from the perspective of the property rights of enterprises. According to the regression results in column 1 of this part of the table, it is known that the state-owned enterprises show an N-type environmental Kuznets curve. The coefficient of innovation entrepreneurship is not significant, and the coefficient of adventurous spirit is significantly positive at the level of 1%. Due to the relationship between state-owned enterprises and the government, the decision makers of enterprises are often subject to more diverse performance assessments, such as the economic performance of enterprises and the performance of social responsibilities. On the other hand, the state-owned enterprises subject to more administrative supervision and social concern, and the government will also actively participate in the green management and environmental governance activities of state-owned enterprises. Thus, state-owned enterprises can better fulfill their environmental responsibility, implement their environmental strategies, and establish a good corporate image (Li & Xu, 2017). In state-owned enterprises, the side effects of entrepreneurship on the environment are weakening, and specifically, the spirit of innovation does not take place. The scale effects and technical effects negatively influence the environmental quality, but the structural effects have no effect. In column 2, the crossover terms of innovation spirit and the cubic term of corporate output are all significantly negative. Therefore, corporate output has a positive influence on reducing pollution emissions through innovation entrepreneurship.

According to the results of column 3 in this part of the table, it can be found that there is no typical environmental Kuznets curve in private enterprises, and there is no obvious correlation between economic growth and environmental pollution. The negative impact of entrepreneurship on the environment in private enterprises is much larger than in state-owned enterprises. The relationship between private enterprises and the government is relatively distant. Although private enterprises may be restricted by environmental policies, they always adhere to the principle of maximizing benefits and passively assume environmental responsibilities. They have strong profit-making motives, so they are more likely to cause corporate pollution (Yu, Yang, & Zheng, 2017). The scale effect of the environment has deteriorated the environmental performance of enterprises, and the structural effect has a significant negative impact on environmental pollution emissions. It can be found that the technical effects are not significant. This may be because private enterprises have efficiency advantages in the environment compared with state-owned enterprises. That is, private enterprises are more efficient in terms of resource utilization and technology application (He, 2013). Therefore, in private enterprises, more attention may be paid to the application of clean green technology, but the lack of a good atmosphere causes the technical effects of the environment to fully take place.

6. Conclusions and suggestions

This paper verified whether there is an environmental Kuznets curve at the micro level through an empirical study of a sample of 289 polluting companies on the Shanghai and Shenzhen A-share. The sample period is from 2008 to 2017, and the data are unbalanced panel data. Combining the scale effect, technical effect and structural effect of the environment, this paper re-explains the relationship between the higher-order terms of per capita output of enterprises and pollution emissions from the new perspective of entrepreneurship. This paper uses a mediation effect model to further identify the mechanisms of entrepreneurship on the environment through scale change, technological progress and structural transformation. In addition, the paper also analyzes the differences in environmental Kuznets curves, including different industry attributes, regional differences and different property rights.

Through the above analysis, this paper mainly draws the following research conclusions:

(1) There are three main types of relationships between environmental pollution and income levels, as follows: monotonic relationships, inverted U-shaped or positive U-shaped relationships, and N-type or S-type relationships. According to the analysis of this paper, from the micro level of the enterprise, there is an N-type environmental Kuznets curve. This type of economic-environment curve is formed under the combined effect of the scale effect, technology effect, structure effect and entrepreneurship. The extended EKC model verified the relationship between entrepreneurship and corporate environmental performance and found that in most cases, entrepreneurship increases corporate pollution emissions, which is not conducive to improving the environmental quality, but entrepreneurs may have a positive influence on environmental problems. The effects of scale, technology and entrepreneurship on the environment are negative, and the effects of structure on the environment are positive.
(2) Three types of mechanisms that affect entrepreneurs' environmental pollution emissions can be identified. Entrepreneurship promotes the technological progress of enterprises and further exacerbates the environment through the mediation effect of technological progress. Environmental regulation negatively moderates the impact of technical effects on pollution. Entrepreneurship promotes the productive scale of enterprises, and it increases corporate pollution emissions through the mediation effect of the scale effect; additionally, environmental regulation negatively moderates the impact of the scale effect on pollution. Entrepreneurship is not conducive to the transformation and upgrading of the corporate structure, but it deteriorates the ecological environment through the mediation effect of structural effects.
(3) From the heterogeneity study, it can be found that there are different environmental Kuznets curves in different industries, geographical locations and equity structures. The impacts of entrepreneurship on corporate environmental pollution emissions are also different.

According to the results of the EKC expansion model in this paper, adventurous entrepreneurship reflects the adverse effects of entrepreneurship on the environment in most cases, while innovative entrepreneurship shows both sides of its impact on the environment. On the one hand, the innovative spirit used in pollution production will have a negative impact on the environment. On the other hand, the innovative spirit used in cleaner production can improve the environmental quality. However, measuring the innovative spirit is not easy. Classifying the innovative spirit is a future research direction. For example, we separate the green innovative spirit from innovative entrepreneurship and further study the relationship between green innovative entrepreneurship and corporate environmental performance.

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