

Research article

Environmental management and labor productivity: The moderating role of quality management

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ABSTRACT

Abundant studies have been made around the impact of environmental management on economic performance in business, but there is still no consistent conclusion. This study focuses on labor productivity as a measure of economic performance. We argue that environmental management has a negative impact on the labor productivity of company in the special context of Chinese increasingly stringent environmental regulations, but this impact is moderated by quality management. Environmental management score and the years that companies have passed ISO 9001 are set as proxies for independent and moderating variable respectively. A sample including 229 Chinese listed companies is used to test the hypotheses by multiple regression analysis. Results show that environmental management has a negative impact on labor productivity, and quality management moderates the relationship.

1. Introduction

As the world's second largest economy entity, China's rapid economic development has attracted worldwide attention. The continuous economic growth is accompanied by a large amount of energy consumption and pollutant emissions (Marquis and ZhangZhou, 2012; Shu et al., 2016). In order to ensure stable economic development, the Chinese government has proposed a development concept of innovation, coordination, green, openness, and sharing, and formulated targets for reducing energy consumption and pollutant emissions. Guided by the conviction that lucid water and lush mountains are invaluable assets, the country will speed up the construction of a resource-conserving and environment-friendly society (National Development and Reform Commission, 2016). At the same time, due to the improvement of environmental awareness, stakeholders such as consumers and environmental organizations are paying more attention to companies' environmental pollution (Li et al., 2017; He et al., 2019). Many Chinese companies are under pressure and have to adopt environmental management initiatives to prevent and control environmental pollution (Yang et al., 2010; Xie et al., 2016).

Environmental management can effectively improve companies' environmental performance, but it requires additional investment by companies at the same time, which will inevitably affect the production and operation of companies. Abundant studies have been made around

the impact of environmental management on company economic performance. Labor productivity is an economic performance that is often used in these researches. But the extant literature has not yet reached a consistent conclusion. Some scholars believe that environmental management can improve the working condition and employees' health, enhance employee satisfaction, and thus promote companies' labor productivity (Turban and Greening, 1997; Reinhardt, 1999; Berman and Bui, 2001; Alpay et al., 2002; Ahmad and Schroeder, 2002; Wagner, 2011; Delmas and Pekovic, 2012; Aragon-Correa et al., 2013). However, some studies have found that environmental management affects the daily production and operation activities and reduces the labor productivity (Christiansen and Haveman, 1981; Gollop and Mark, 1983; Jaffe et al., 1995; Portney and Stavins, 2000; Becker, 2011; Nishitani et al., 2012; Riillo, 2013; Fujii et al., 2013; Harvey et al., 2013; Aguilera and Ortiz, 2013; Jackson et al., 2014; Lannelongue et al., 2017; Frondel et al., 2018).

While arguing which views are correct, researchers are beginning to recognize the important role of specific contexts in the success of environmental management, such as regional development levels, industry types, and company size (Melnyk et al., 2003; Matten and Moon, 2008; Wiengarten et al., 2012). Considering the heterogeneity of the impact of environmental management on labor productivity, this paper especially studies the moderating role of quality management considering the many similarities between these two management practices (Curkovic

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et al., 2008; Wiengarten and Pagell, 2012).

The potential contributions of this paper are as follows: Firstly, we examine the impact of environmental management on labor productivity under the increasingly stringent environmental regulation in China. As U.S. President Donald Trump announced that America would be withdrawing from the Paris Climate Agreement, China, the world's second largest economy entity, will undertake heavier responsibilities in the global environmental improvement. At the same time, China is also the world's largest transitional entity. Therefore, studying environmental management issues in conjunction with Chinese background will contribute to global sustainable development. Secondly, we consider the moderating role of quality management. Compared with environmental management, quality management has a broader foundation in China (ISO, 2018). Therefore, the study on the moderating effect of quality management is conducive to providing evidence for the promotion of environmental management in companies. The research result confirms that the high level of quality management foundation can restrain the troubles caused by environmental management to companies, thus can improve labor productivity. This conclusion helps to explain the heterogeneity of environmental management effects and to provide confidence for company managers.

2. Literature review and hypotheses

To ensure that the literature review and theoretical analysis of this study are comprehensive, we employed the following search techniques to identify relevant literature. We searched five computerized databases (i.e., ABI/Inform, Web of Science, Science Direct, Wiley, and JSTOR) that include most business journals. We used the following search terms: environmental management, environmental strategies, environmental regulation, ISO 14001, quality management, ISO 9001. We manually searched several journals highly cited in the field of environmental management and sustainability, such as *Journal of Environmental Management*, *Journal of Cleaner Production*, *Journal of Business Ethics*, *Journal of Environmental Economics and Management*, and *Business Strategy and the Environment*. In order not to omit the early relevant literature, we searched studies published prior to 2018. The following criteria were used to select the literature: (1) the articles must contain at least one relationship between environmental management, quality management and labor productivity; (2) the studies must measure the constructs at the firm level. We will develop the hypotheses on the basis of literature review.

2.1. Environmental management and labor productivity

Environmental management is the proper initiatives that companies take to improve environmental performance (Delmas, 2002; Darnall et al., 2010). It is a complex process that requires cross-departmental coordination and major changes in present operational processes (Russo and Fouts, 1997). In order to promote environmental management, the International Organization for Standardization established the environmental management system standards in 1996. The environmental initiatives include establishing environmental management departments, designing environmental management procedures, transforming or updating production equipment, recording environmental protection information, training relevant personnel, and changing corporate culture, etc (Walley and Whitehead, 1994; Cañón-de-Francia et al., 2007; Harvey et al., 2013; Jackson et al., 2014; Frondel et al., 2018). By the end of 2018, 136,715 companies in China had passed the ISO14001 environmental management system certification (ISO, 2018).

With the increase of globalization and intensification of market competition, labor productivity has become an important factor in company competition. Higher labor productivity means lower unit costs, and companies can have a greater advantage in competition. Therefore, while implementing environmental management, companies must pay

attention to its impact on labor productivity (Repetto, 1990; Solow, 1992; Jasch, 2006; Almeida and Carneiro, 2009; Riillo, 2013; Fujii et al., 2013; Lannelonguel et al., 2017).

Some scholars think environmental management is conducive to labor productivity. Firstly, environmental management can improve employees' satisfaction, and good environmental management can make employees feel proud of their companies and perform better (Reinhardt, 1999). Secondly, environmental management can reduce labor cost. Pollution emissions are harmful to employees' health. Better environmental performance can reduce employee sick leave and absenteeism, then reduce the need to recruit new employees, thereby reduce labor costs (Ahmad and Schroeder, 2002; Wagner, 2011). Thirdly, environmental management promotes more employee training and cross-departmental collaboration (Delmas and Pekovic, 2012). This kind of training helps to strengthen employee recognition of the company, and cross-departmental cooperation increases knowledge sharing and better interpersonal relationships among employees (Aragon-Correa et al., 2013). These benefits will ultimately be reflected at labor productivity.

However, there are also opposite viewpoint. Firstly, environmental management generates non-core business activities such as system design, process documentation, environmental consulting, environmental auditing, waste management, environmental litigation, and employee training, which may adversely affect company labor productivity (Harvey et al., 2013; Jackson et al., 2014; Frondel et al., 2018). These non-core business tasks need resources, funds and labors which occupy productive investment (Fujii et al., 2013; Lannelonguel et al., 2017), ultimately have a negative impact on labor productivity (Jaffe et al., 1995; Becker, 2011; Porter and Linde, 1995; Ambec and Lanoie, 2008). Secondly, strict environmental management will also reduce the flexibility of companies to deal with environmental issues. For example, environmental management often requires significant changes in the production systems, which needs companies to change their production processes and use more environmentally friendly technologies and equipments (Portney and Stavins, 2000; Aguilera and Ortiz, 2013). Many scholars have found that environmental management has a negative impact on labor productivity (Christiansen and Haveman, 1981; Gollop and Mark, 1983; Ambec and Lanoie, 2008; Riillo, 2013).

The Chinese central government has recently taken many initiatives to effectively promote environmental improvement. In order to achieve a significant increase in energy efficiency and clean production by 2020, it has raised environmental standards and conducted strict environmental inspections throughout the country, ordering companies with unsatisfactory environmental performance to stop production and rectify (Li et al., 2017; He et al., 2019). In addition, considering the impact of environmental regulation on economic development, Chinese central government has deliberately lowered its expectation for economic growth (National Development and Reform Commission, 2016). Therefore, Chinese companies must comply with more stringent and comprehensive environmental regulations, which force them to invest huge capital and human resources in environmental management, limit the flexibility of production and operation, and affect their labor productivity.

Therefore, considering the background of Chinese environmental regulation during the economic development transition period, this paper argues that:

H1. Environmental management negatively affects the labor productivity of companies.

2.2. Quality management and labor productivity

Quality management is an effective management tool designed to help companies achieve better performance by continuously improving production processes and technologies, as well as improving the quality of products and services (Garvin, 1984; Levine and Toffel, 2010). An

outstanding feature of quality management is that it provides an automatic control mechanism to ensure the quality of production, with ISO9001 being the most widely accepted quality management system (Chapman and Khleef, 2002; Fonseca, 2015a). ISO 9001 has established relevant implementation principles and requirements for companies, including: (1) customer focus; (2) leadership; (3) engagement of people; (4) process approach; (5) improvement; (6) evidence-based decision making; (7) relationship management (Fonseca, 2015a). According to these principles and requirements, companies can achieve continuous improvement in quality and economic performance (Levine and Toffel, 2010; Goetsch and Davis, 2000; Chapman and Khleef, 2002; Heras et al., 2011; Fonseca, 2015b). By the end of 2018, the number of valid certificates for ISO 9001 in China was 295,703 (ISO, 2018).

Quality management requires companies to establish a set of procedure standards for product design, manufacturing, delivery, and service to ensure that customers always receive products or services the company promises. By doing so it can attract employees' attention to details and keep employees comply with procedural rules (Wiengarten et al., 2017). It will conducive to employees' efficiency. Quality management also requires companies to monitor their operation quality continuously. By doing this, it can reduce operation errors and then enhance labor productivity (Albulescu et al., 2016; Martinez-Costa et al., 2009; Kaynak, 2003; Naveh and Erez, 2006). A well-functioning quality management system can reduce costs, increase productivity and customer satisfaction, thereby enhance the competitiveness of companies (Hunt and Auster, 1990; Sroufe and Curkovic, 2008; Wiengarten and Pagell, 2012). The cost of quality management always be regarded as investment, which can bring more benefits to the company in the future (McAdam and McKeown, 1999; Lafuente et al., 2010). Therefore, this paper proposes the following hypothesis:

H2. The higher the quality management level, the higher the labor productivity of the company.

2.3. The moderating role of quality management

In fact, quality management and environmental management have many similarities in management practice (Kleiner, 1991; Klassen and McLaughlin, 1993; Curkovic et al., 2008; Wiengarten and Pagell, 2012). Both of them emphasize continuous assessment and improvement, inter-departmental cooperation and employee participation, etc (Flynn et al., 1994; Kaynak, 2003; Pereira-Moliner et al., 2012). Considering the similarities between quality management and environmental management, companies with successful quality management experience are more likely to respond to the uncertainties brought about by environmental management and successfully implement advanced environmental management strategies (Molina-Azorin et al., 2009). The reasons are as follows:

- (1) Environmental management requires the support of human resources, especially employee participation and training (Del Brío and Junquera, 2003). Employees with relevant knowledge and skills tend to adopt new technologies and comply with new management practices (Frambach and Schillewaert, 2002). **Error! Reference source not found..** Companies with well-performed quality management system always value employee participation and training. Employees in companies with an efficient quality management system already have awareness and commitment to employee participation, making it easier to understand what environmental management is (Curkovic et al., 2000). The companies' quality management system can be used as the basis for environmental management.
- (2) The experience from successful quality management can be used to develop new plans and initiatives related to environmental management. If employees have quality management experience, understand the procedures of quality management, be able to

handle quality management records and fill in relevant documents proficiently, they can complete environmental information recording and document preparation for environmental management effectively (Darnall and Edwards, 2006; Wiengarten and Pagell, 2012; Molina-Azorin et al., 2015).

Therefore, environmental management may be better implemented in companies with higher quality management level. The following hypothesis is proposed.

H3. Environmental management has less negative impact on labor productivity for companies with high quality management.

The theoretical framework of this paper is shown in Fig. 1:

3. Methodology

3.1. Sample selection

Manufacturing industry often produces a lot of pollution during its production and operation, and faces stringent environmental protection supervision and stakeholder pressure (Yang et al., 2010; Xie et al., 2016). Therefore, this study selects listed manufacturing companies in Shanghai Stock Exchange and Shenzhen Stock Exchange in China.

3.2. Variables

- (1) Independent variable: environmental management

Although ISO14001 certification is often used in extant research to measure environmental management (Poksinska et al., 2003; Tari et al., 2012; Fonseca et al., 2017; Fonseca and Domingues, 2018), another proxy variable is adopted (Chatterji et al., 2009) considering the Chinese context. Environmental management started late in China, and many companies did not have ISO14001 certification. The environmental responsibility score provides a more extensive and comprehensive evaluation of the company's efforts in environmental management (including those firms that did not pass ISO14001 certification). In addition, through the moderate of quality management, the expected research results can provide confidence for companies that have already passed ISO14001 certification, and can also encourage those companies that are not certified ISO14001. Therefore, it is more appropriate to choose environmental responsibility scores to measure environmental management.

The data is gotten from Hexun website. Hexun is the largest financial information publishing website in China. According to the annual reports and social responsibility reports issued by the listed companies, the website calculated the environmental responsibility score of the listed companies. A natural logarithm is taken.

- (2) Dependent variable: labor productivity

It is taken as the natural logarithm of per capita sales (Lannelongue et al., 2017).

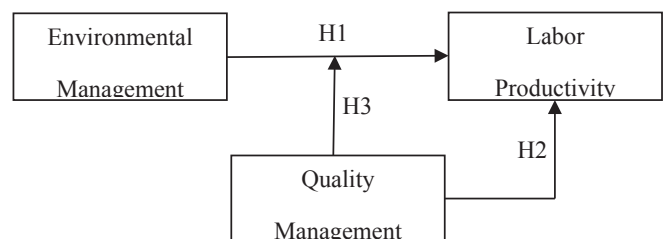


Fig. 1. Conceptual model.

(3) Moderating variable: quality management

It is measured by the natural logarithm of the number of years the company has passed ISO quality certification (Heras et al., 2011; Fonseca, 2015b).

(4) Control variables

Company size: The larger the company, the larger the business scale, so a potentially important impact on labor productivity (Pfeffer and Langton, 1993; Zwick, 2004). It is measured by the natural logarithm of the total assets of the company.

Industry: Different industries are subject to different environmental pressures. Heavy polluting industry can cause great harm to employees' health. Therefore, industry is an important variable to study environmental management and labor productivity (Lannelonguel et al., 2017). The industry to which the company belongs is classified according to the "Industry Classification Guide for Listed Companies" issued by Chinese Securities and Regulatory Commission (CSRC).

Export: Studies have shown that exports can further increase the productivity of companies due to the influence of learning and competition (Greenaway and Kneller, 2007). Export activities of listed companies are measured by the proportion of their overseas business income (including Hong Kong, Macao and Taiwan) to their total business income.

Management level: Management level is an important factor affecting the labor productivity of companies because of its effect on the allocation of physical capital and human capital (Acemoglu et al., 2018). It is measured by the proportion of management expenses to the operating income of the company.

Innovation level: Studies have shown that there is a positive correlation between innovation and labor productivity (Kurt and Kurt, 2015). It is measured by the proportion of R&D expenditures to the company's operating income.

Company age: Some scholars believe that company age is an important factor influencing company productivity (Dunne and Hughes, 1994; Jensen et al., 2001). It is measured by the natural logarithm of the number of years the company was founded.

3.3. Data

The environmental responsibility score is derived from Social Responsibility Score Report issued by Hexun in the year 2016. Hexun is the largest financial information publishing website in China and cooperates with Thomson Reuters, the world's largest provider of financial information data and analytics products. As the first institution in China to conduct professional evaluation on environmental responsibility for listed companies, Hexun rated the company's environmental responsibility in five aspects: corporate environmental awareness, environmental management system certification, environmental investment, number of information relative to pollutants, and number of information relative to energy conservation. The raw data Hexun used to evaluate environmental responsibility comes from the social responsibility report and annual report issued by listed companies. Quality management data

is from the National Certification and Accreditation Information Public Service Platform, a database providing company certification and accreditation information sponsored by the Certification and Accreditation Administration of China. Other data are from CSMAR Database, a widely used database for listed companies in China. After eliminating companies that do not have environmental responsibility scores and incomplete data, we obtain 229 companies involved in 17 manufacturing industries. Table 1 shows the details of the industry distribution.

4. Research result

4.1. Descriptive statistics and correlation analysis

Descriptive statistics and Pearson correlation coefficients of variables are shown in Table 2. The variance expansion factor (VIF) is less than 2, indicating that there is no collinearity between the variables. Variables are centralized when constructing interactive items later (Dalal and Zickar, 2012).

4.2. Regression results

Table 3 gives the regression results of the models. Model 1 examines the impact of each control variable on labor productivity. The independent variable is added to Model 2, and the result indicates that environmental management has a negative impact on company's labor productivity ($\beta = -0.211, p < 0.001$). Therefore, Hypothesis 1 is supported. The impact of quality management on labor productivity is shown in Model 3 ($\beta = 0.178, p < 0.01$). This indicates that quality management positively affects company's labor productivity. So Hypothesis 2 is supported. Model 4 examines the moderating role of quality management. The adjusted R² increases by 0.029. This shows that the explanation power of Model 4 is larger than Model 3. The interaction item of quality management and environmental management has a significant effect on labor productivity ($\beta = 0.174, P < 0.001$). Following the procedure proposed by Aiken and West (1991), we have taken three values for the variables of environmental management and quality management respectively: mean, mean minus one standard deviation, and mean plus one standard deviation. The moderating effect is shown in Fig. 2. It can be seen that the labor productivity of companies with low quality management level is more negatively affected by environmental management, while in companies with moderate quality management level, environmental management has less negative impact on labor productivity. And for companies with high level of quality management, the impact of environmental management on productivity is positive. Therefore, Hypothesis 3 is supported.

4.3. Discussions

There is a negative relationship between environmental management and labor productivity. This result is consistent with the conclusions of previous studies (Jaffe et al., 1995; Becker, 2011; Lannelonguel et al., 2017; Frondel et al., 2018). It suggests that environmental management can reduce the labor productivity of companies, and the

Table 1
Industry distribution of sample companies.

Min	PHPS	EMEM	EEM	Tex	CFM	BMM	MM	AM
4.80%	6.11%	8.30%	11.35%	2.62%	1.31%	3.93%	8.73%	4.80%
OTEM	Pet	FB	GEM	RPP	PM	PI	SEM	
1.31%	11.79%	8.30%	3.93%	1.75%	10.92%	3.49%	6.55%	

Note: Min: mining; PHPS: power and heat production and supply; EMEM: electrical machinery and equipment manufacturing; EEM: electronic equipment manufacturing; Tex: textiles; CFM: chemical fiber manufacturing; BMM: building materials manufacturing; MM: metal manufacturing; AM: automobile manufacturing; OTEM: other transportation equipment manufacturing; Pet: petrochemicals; FB: food and beverage; GEM: general equipment manufacturing; RPP: rubber and plastic products; PM: pharmaceutical manufacturing; PI: paper industry; SEM: special equipment manufacturing.

Table 2
Descriptive statistics and correlation coefficients.

Variables	Mean	S.D.	1	2	3	4	5	6	7	8
1	13.75	1.26	1.000							
2	0.15	0.21	-0.063	1.000						
3	0.09	0.05	-0.323**	0.102	1.000					
4	0.03	0.03	-0.170*	0.263**	0.454**	1.000				
5	3.08	0.21	-0.075	-0.177**	-0.049	-0.058	1.000			
6	9.01	5.00	-0.220**	-0.024	0.040	0.015	0.098	1.000		
7	2.66	0.35	-0.060	0.108	0.157*	-0.003	-0.047	0.079	1.000	
8	2.47	0.46	-0.079	-0.077	-0.016	0.102	0.138*	0.211**	-0.016	1.000
9	4.60	0.63	0.323**	-0.156*	-0.519**	-0.116	0.045	-0.028	-0.310**	0.196**

Note: *p < 0.05; **p < 0.01; S.D. = Standard Deviation; 1 = Firm Size; 2 = Export; 3 = Management Level; 4 = Innovation Level; 5 = Firm Age; 6 = Industry Type; 7 = Environmental Management; 8 = Quality Management; 9 = Labor Productivity.

Table 3
Regression results.

Variables	Labor Productivity			
	Model 1	Model 2	Model 3	Model 4
Firm Size	0.182**	0.183**	0.190***	0.209***
Export	-0.138*	-0.113*	-0.097	-0.095
Management Level	-0.535***	-0.493***	-0.475***	-0.450***
Innovation Level	0.195**	0.168**	0.138*	0.133*
Firm Age	0.017	0.011	-0.008	-0.010
Industry Type	0.026	0.043	0.009	0.017
Environmental Management		-0.211***	-0.211***	-0.233***
Quality Management			0.178**	0.180***
Environmental Management × Quality Management				0.174***
R ²	0.336	0.378	0.407	0.436
Adjusted R ²	0.318	0.358	0.386	0.413
ΔR ²	0.336	0.042	0.029	0.029
F	18.700***	19.192***	18.882***	18.844***
ΔF	18.700***	15.048***	10.771**	11.397***

Note: *p < 0.05; **p < 0.01; ***p < 0.001.

reasons for this phenomenon may be as follows. On the one hand, environmental management forces companies to invest more resources and labor into non-core business activities, such as environmental certification, environmental documentation, and waste disposal, which may adversely affect the labor productivity of companies. On the other hand, strict environmental management will require companies to change production processes, update production equipment, reduce the flexibility of companies to deal with environmental issues, and occupy a

large amount of productive investment.

Quality management has a positive impact on labor productivity. Quality management can help companies continuously monitor and manage the quality of all business operations, prevent errors in the production process, and motivate employees to improve work efficiency. The research findings of Goetsch and Davis (2000), Chapman and Khleef (2002), Heras et al. (2011) and Fonseca (2015b) also confirm this view.

Quality management plays a moderating role in the relationship between environmental management and labor productivity. The quality management experience can help to reduce burdens from environmental management investment and process transformation, improve the efficiency of employees when they handle environmental problems, and reduce the negative impact of environmental management on labor productivity as a whole (Curkovic et al., 2000; Wiengarten and Pagell, 2012).

5. Conclusions, limitations and future research

5.1. Conclusions

This study analyzes the impact of environmental management on labor productivity. The empirical results are consistent with the relevant research conclusions mentioned above. Specially, we also analyze the dual roles of quality management in this relationship, on the one hand as a direct influencing factor on labor productivity, and on the other hand as a moderator between environmental management and labor productivity. The conclusions are as follows: Firstly, environmental management has an important impact on the labor productivity, and high environmental management level will lead to a decrease in labor

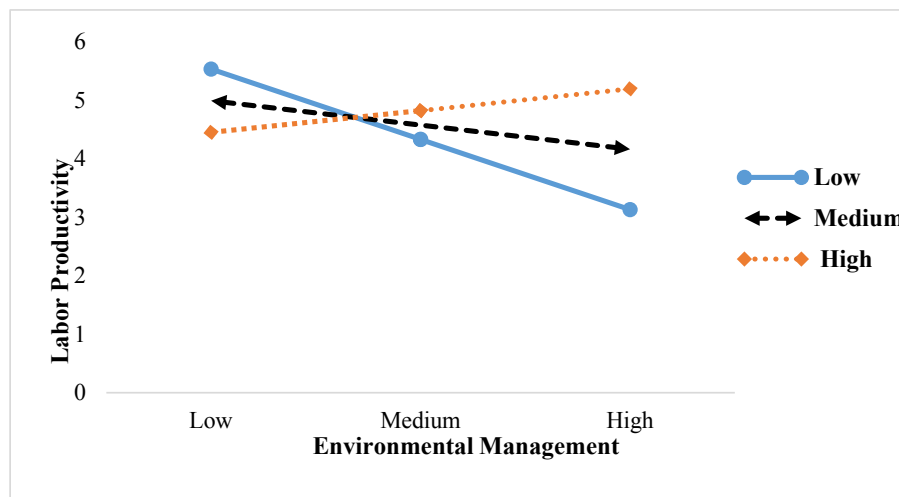


Fig. 2. Interaction graph.

productivity. Secondly, different from the negative impact of environmental management on labor productivity, the higher the quality management level, the higher the labor productivity. Thirdly, when we distinguish these companies according to the quality management level, we find that in companies with high quality management level, the negative impact of environmental management on labor productivity is reduced.

5.2. Implications

The conclusions in this study can provide enlightenment for both academia and practitioners.

This study has made new contributions to understanding the relationship between environmental management and labor productivity. Firstly, we empirically test the relationship between environmental management and labor productivity. The test results also provide additional evidence for previous studies. Secondly, we introduced quality management as a moderating variable in our research. It provides new inspiration for scholars that specific conditions have an important impact on the relationship between environmental management and labor productivity.

This study also has important implications and guidance for practitioners. The management foundation of Chinese companies is relatively weak, and Chinese environmental regulation is becoming more stringent than ever, so overall, environmental management has a negative impact on company labor productivity. However, for companies with high management level, such as companies with long-term quality management adoption, this negative impact will gradually reduce or disappear with the continuous advancement and maturity of environmental management. Therefore, managers should firmly believe that environmental management is a management practice that is conducive to the environment and the economy. Considering the moderating effect of quality management, companies should integrate advanced quality management methods and experience into environmental management practices, as doing so may yield superior results. In terms of specific practices, companies can focus on measures such as employee training, cross-departmental coordination, company culture construction, environmental goal formulation and environmental performance assessment.

5.3. Limitations and future research

Due to the limitations of measurement and data, only 229 manufacturing companies are selected. Future research can expand the sample size, cover more industries and companies, and improve the universality of the research results. We should also indicate that our research only focuses on the moderating role of quality management. In order to further clarify the relationship between environmental management and labor productivity, future research can choose other moderating variables for testing.

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