

Why do firms engage in environmental management? An empirical study in China

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Abstract

There are increasing pressures being put on firms, from a number of different sources, such as governmental regulation, community participation and market demand, to engage firms in environmental initiatives. These factors play different roles at various development periods. Government regulation was the major pressure, initially. However, community participation and market demand have become more and more important. Thus a better understanding of the determinant factors that play a role in engaging firms to take environmental management initiatives may help policy makers develop more effective environmental policies. Using data collected from 89 firms in Wujin county of Jiangsu Province, China, this paper developed an index system to evaluate the corporate environmental management performance. Furthermore, we used econometric methodology to identify the main factors that probably shape corporate environmental management performance, including both external pressures and firm characteristics. The results showed that pressures from supply chain, customers, and communities played positive roles in engaging firms to improve environmental management performance. However, the pressure from the regulatory system did not implicate positive effect on environmental management performance when basic compliance is not an issue in the region anymore. The results also showed that firms with larger scale will be more active in engaging in environmental management initiatives. Finally, our results suggest that: (a) regulation's stimulation may be reduced as long as firms have complied with requirements of local environmental standards and other environmental laws; (b) policy makers should pay more attention to market and information instruments; (c) more financial and technical support should be provided to encourage small- and medium-sized enterprises (SMEs) to improve environmental performance.

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1. Introduction

Chinese government has paid great attention to environmental issues arising from the country's population growth and economic development, and made environment protection as an important aspect of the improvement of people's living standards and quality of life. In order to promote coordinated development between the economy, the society and the

environment, China has enacted and implemented a series of principles, policies and laws since the 1980s. Until recently, environmental policy was set up typically on the belief of regulatory framework. Undisputedly, the past regulatory approaches have made great progress in cleaning up country's land, air and water, and preventing the environment from further deterioration. However, the public and private costs on this environmental protection strategy are considerable.

On the other hand, it seems that conventional policy discussion has been too narrow, focusing only on the firm–state interaction as the single determinant of environmental performance. Indeed, firms have become more aware of the importance of environmental issues at all levels of their operations, and

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have been influenced not only by governments but also by a plethora of stakeholders such as shareholders, employees, neighborhood residents, and trade associations [1]. Each of these pressures presents firms with a daunting array of potential environmental risks [2]. Thus, alternative approaches such as financial incentives, business-led voluntary programs, public–private partnerships, information disclosure, and labeling could trim that figure considerably while achieving the same or better environmental objectives.

The difficulty is in knowing whether the alternative approaches are best suited and getting firms to respond predictably to these alternatives. Thus, it is important to identify the elementary motivation and principal factors which shape firms to engage in environmental protection initiatives.

Therefore, the central objective of this research is to analyze the impact of formal and informal regulations on the level of firms' environmental performance. Informal regulation includes two new agents, the community (local or neighboring community) and the market (market agents such as consumers and investors), which also participate in the process of environmental regulation through private enforcement. This paper also analyzes the impact of firms' characteristics on their environmental performance.

The next part of the paper provides a review of previous studies related to the topic. Section 3 presents the background of our research site. Section 4 focuses on the data collection, and the empirical model construction. Section 5 explains the research findings, and Section 6 concludes with suggestions.

2. Literature review

There is increasing pressure on firms, from a number of different sources, to engage in environmental management initiatives. Government regulation was the major initial environmental pressure. However, community and market have become the determinant factors as they play more active roles in environmental protection in developed countries [3].

Certain strategic choices can be imposed coercively through sanction or threat, as in the case of a government legally mandating environmental standards [4,5]. Government regulation, including inspections and enforcement actions, is one of the most important factors affecting a firm's decision making process [2]. However, Cohen [6] reports that surprisingly few empirical studies of environmental enforcement have been conducted in the USA. In the economics literature, a few articles have examined the effectiveness of government interventions on facility environmental performance involving standard emissions (i.e., non-accidental discharges). These studies began by focusing exclusively on two industrial sectors — pulp/paperboard and steel [7–12]. Later, expanding to other sectors, May and Winter [13] examined the compliance with agro-environmental regulations in Denmark. Stafford examined the effect of a new United States Environmental Protection Agency (US EPA) enforcement protocol on facility compliance with hazardous waste regulations [14]. Reijnders examined the regulatory influence on cleaner production and found that regulation by permits based on adequate law and related negotiated

agreements might emerge as more specific instruments furthering cleaner production [15].

Recently, the United States Environmental Protection Agency (US EPA) has expressed a strong interest in getting a better understanding of the factors that shape environmental performance at individual polluting facilities [16]. Subsequently, Earnhart analyzed the regulatory factors that shape the level of environmental performance at municipal wastewater treatment plants in the state of Kansas for the years 1990–1998 [17]. Gray and Shadbegian examined the determinants of environmental regulatory activity (inspections and enforcement actions) and levels of air and water pollution for 409 US pulp and paper mills, using data from 1985 to 1997 [18]. Evangelinos assessed the regulatory and environmental problems of mining operations in the Cyclades, Greece [19]. Mendivil et al. presented a systematic approach to introduce the evolution of technology, market and environmental regulations on the past and future performance of chemical processes [20]. Triebswetter and Hitchens examined, through three case studies, whether German industrial plants suffered from a negative impact on competitiveness caused by stringent environmental legislation [21]. The results showed that abatement initiatives had, in general, been implemented without economic damage and did not touch on the core business. Mutagwaba analyzed the benefits and challenges of implementing environmental regulatory program for mining industry in Tanzania [22].

Some economic studies examined the effects of non-regulatory factors on corporate environmental performance and/or behavior. In particular, these studies explored the reasons for over-compliance¹, which cannot be explained by regulatory pressure. Arora and Cason explored firms' desire to present a “green” image to consumers [23]. Vachon and Klassen pointed out that, by interacting with their suppliers and their customers, manufacturing organizations could potentially develop and implement more effective solutions to environmental challenges they are facing [24]. Zhu et al. found that market pressure was a strong driver for the adoption of the green supply chain management practice by Chinese automobile supply chain enterprises [25].

Many other studies have shown that most consumers would more likely choose environment-friendly products [26–28]. Wen and Chang considered the driver of market demand to be a great power that shaped better corporate environmental performance in Taiwan [29]. Others reported that capital markets may react negatively to the announcement of adverse environmental incidents, such as violation of permits, spills, court actions, complaints or react positively to the announcement of superior environmental performance [30]. Eriksson analyzed to what extent partial and voluntary internalization of negative environmental externalities can replace public interventions in a duopoly market [31]. The results showed that a modest degree of idealism could not replace environmental regulation.

¹ Better achievement of environmental performance standards set by law or regulations.

Community pressure may also explain over-compliance. A few economic studies explicitly explored the effect of community pressure on environmental performance and/or behavior. For example, Henriques explored the effect of self-reported community pressure on Canadian firms' decisions to adopt an environmental plan [2]. Dasgupta et al. explored the effect of self-reported community pressure (presence versus absence) on Mexican firms' decisions to adopt certain environmental management practices [30]. Maxwell et al. explored firms' desire to preempt citizen political action for more stringent regulations at the state level; the expectation of citizen lobbying affected facilities' decisions to reduce emissions [32]. Hamilton examined how hazardous waste facilities considered the potential for community action when deciding where to locate [33]. Pargal and Wheeler explored the effects of community characteristics on facility-level industrial wastewater discharges in Indonesia and interpreted these characteristics as capturing community-generated "informal regulation" against facilities [34]. Wolverton examined the effects of community characteristics on the location decisions of Texas plants that report Toxic Release Inventory (TRI) emissions [35]. Becker examined whether community characteristics help to explain the level of pollution abatement expenditures by manufacturing plants in the USA [36]. Earnhart examined the effects of community characteristics on polluter compliance levels in the state of Kansas during the years 1990–1998 [49]. Estimation revealed community characteristics significantly affected both regulatory interventions and facility performance.

Corporate environmental performance can also be affected by a firm's own characteristics (ownership, size, financial status, etc.). For example, Henriques identified that firms in the natural resource sector are more likely to formulate environmental plans, while firms in the service sector are less likely to have plans [2]. Downing and Kimbal assessed the possibility that management's concerns about corporate image induce over-compliance [37]. Gray and Deily examined the link from firm-level financial status to facility-level environmental performance in the USA [7]. Other studies explored the relationships between firm-level financial status and firm-level environmental performance [38–40].

As can be seen from this short review of literature, we assume that firms' engagement in environmental management can be influenced by their own characteristics (ability aspects), market opportunities (incentive aspects), regulatory procedures (sanction aspects) and community pressure (informal aspects). However, most of the recent research focused on single factor's influence on corporate environmental performance, for example regulation and compliance. But firms usually make decisions with a full consideration of all factors. Thus an integrated approach with all factors taken into account should be adopted. On the other hand, such researches in China are limited, though China has an urgent demand of effective environmental polices. Therefore, this paper takes Wujin county in China as the study area and provides an integrated analysis of the determinant factors engaging firms in environmental management initiatives.

3. Environmental regulation and enforcement in Wujin county

China has implemented an environmental management system, whereby governments at all levels are responsible for the environmental quality of the areas within their jurisdictions. The competent administrative departments in-charge of environmental protection have the power of overall supervision and management, while other relevant departments exercise such supervision and management functions according to the provisions of the law. In 1998 the Chinese government changed the name of the state environmental protection bureau to the State Environmental Protection Administration (SEPA), and elevated it to the ministerial level. The governments of all the provinces (autonomous regions and municipalities directly under the central government), cities and counties have set up organs responsible for addressing and coordinating environmental protection issues. There are now 3226 environmental protection administration departments at different levels all over the country, with 167,000 people engaging in environmental administration, monitoring, scientific research, publicity and education. There are 3854 environmental supervision and environmental law enforcement organs with more than 50,000 staff members. Environmental protection organs are also found in some government departments for comprehensive affairs or resource administration departments, as well as in most large- and medium-sized enterprises, responsible for their own environmental protection duties. More than 300,000 people are employed by these organs [41].

We chose Wujin county in Jiangsu Province, China, as a location for our case study site. A county nearing one million population, with land area of 1242 square kilometers, Wujin county sits in the middle of Yangtze river delta (Fig. 1), which is the most developed area in China. In the past two decades, Wujin has achieved a fast economic growth rate, with GDP increasing from \$228 million in 1985 to \$4850 million in 2004.²

Firms in Wujin county face various environmental standards and policies. Firms should discharge pollution under the concentration standards of local level which is usually stricter than state level. Firms will be charged for their emission according to the discharging quantity of pollutants. Cleaner production and ISO 14000 authentication are also encouraged by government but not imperative.

When firms are caught on non-compliance status, fine is the most usual punishment. The fine value is determined by the local EPB according to the degree of non-compliance status. Apart from the fine, they are forced to comply with regulation within a certain period of time. However, agreements are usually set between violators and the local EPB, which allows firms a grace period to achieve compliance. The contents of agreements often account for economic constraints faced by firms and the need to compromise with regional development goals that the firm's activities may be related to. Local EPB,

² Data from "Wujin Yearbook 2005".



Fig. 1. Location of Wujin county.

however, in extreme cases, can set plant to stop emission discharge, or suggest local governments to shut down the non-compliance firms.

As one of the most developed areas in China, regular compliance was a basic requirement for firms in the region. More than 95% of firms in Wujin county could comply with the discharge standards and other environmental laws, but the environmental quality was still far from satisfaction. Government was seeking for new instruments to promote corporate environmental performance. Since 2003, the corporate environmental information disclosure program was conducted in Wujin. The color-coded ratings are generated by a detailed accounting of environmental performance. The system divides industrial firms' environmental performance into five symmetric rating categories, with two (black and red) denoting inferior performance; one (yellow) denoting compliance with minimum emission regulations but failure to comply with stricter requirements; and two ratings (blue and green) denoting superior performance [42]. The results of these color-coded ratings are made known to the public, firms, and banks through the media, the internet, and intentional releases from local EPBs. Although the performance information is limited, it can attract the public's attention and promote firms to improve environmental performance to some extent.

Public participation is getting more active in Wujin county. Governments at various levels in China have endeavored to boost public participation in environmental protection. The Environmental Impact Assessment (EIA) law requires public participation and demands appraisal meetings or hearings be held or other forms of participation be taken for planning or construction projects that may cause unfavorable environmental impacts. Along with the public's increasing awareness of the importance of protecting the environment and demand for a better environment, the government has opened hotlines for environmental pollution complaints. The residents can also

complain by letter or interview about infringements on the people's environment-related rights.

4. Research methodology

4.1. Data collection

The data used in the study was taken from a survey of 176 main pollution chemical manufacturing firms and the emission declaration and registering system. The name list of firms was provided by local EPB of Wujin county according to the emission declaration and registering system.

Based on the above literature and contextual background, our questionnaire provided the framework from which we explored corporate environmental management performance and its determinant factors. The questionnaire targeted managers with knowledge of environmental issues affecting their firms, and consists of three parts: (1) general information of firms; (2) environmental management performance, such as whether firms have established environmental management system; (3) sources of pressure, and the ways of current environmental standards affecting firms' environmental management initiatives. The data of pollution discharge were collected from the emission declaration and registering system.

Data were collected in August 2004 by using pre-designed and structured questionnaires. Before the actual interviews were conducted, the questionnaires were pre-tested and reviewed in light of comments from the respondents. Finally, the respondent rate of our survey was 50.6% (89 in 176 firms).

4.2. Econometric approach

4.2.1. Identification of the econometric model

We assume a polluting firm conducts environmental management initiatives according to the behavior cost and benefit.

Here the behavior cost includes environmental management cost. The firms' environmental management costs are affected by firms' characteristics (size, sector, origin of capital, etc.) given by the vector **A** (ability).

The compliance benefit includes the avoidance of non-compliance cost and market incentives. Non-compliance faces costs due to penalties applied by regulators, payments resulting from judicial litigation from accidents and damages to third parties and compensations to community members. The non-compliance costs related to the sanctions applied by regulators, whether resulting from the regulator's inspection or pressure from community members and NGOs, is given by the vectors **R** (regulatory pressure) and **C** (community pressure). The market incentives (export demand with tighter environmental restrictions, subsidized credit, certification, etc.) to increase environmental performance due to their effects on competitiveness (on sales or costs) given by a vector **M** (market pressure).

In saying so, a firm's environmental management performance (EMP) can be presented in a reduced-form expressed as:

$$EMP = f(A, R, C, M) \tag{1}$$

4.2.2. Dependent variable

As mentioned above, we intend to analyze the main factors influencing firms to engage in environmental management initiatives. To carry this on, we need to select an indicator that measures the corporate environmental management performance.

The most appropriate indicator for that purpose would measure firms' pollution impacts. The measure of such indicators, however, is far from being trivial. Assimilative capacity is very difficult to measure because it varies from locality to locality and is pollutant-specific; emission, as well, is not always observed or reported and may take a form of different pollutants [45].

Prior studies addressing this issue of environmental control determinants have proxy indicators utilized instead. These proxies could be broadly classified into four categories, namely: (a) total emissions [34,38]; (b) environmental investments [43]; (c) self-assessed compliance performance [30] and (d) environmental management system [30].

In this case, we examine the overall corporate environmental management performance. Twelve indicators (see Table 1) were chosen to evaluate the level of environmental management performance according to the suggestions from professional experts and prior researches. Every indicator should obtain a score from the survey. The sum of 12 indicators' scores represents the level of overall environmental management performance (EMP). Note that EMP_{*j*} then reflects the level of environmental management practices of the firm *j*. Firm with a higher score reflected better environmental management performance.

4.2.3. Independent variables

Recalling Eq. (1), the independent variables **A**, **R**, **M** and **C** represent the factors ability, regulatory pressure, market

Table 1
Corporate environmental management performance index system

Indicators	Explanation	0	1	2	3	4	5
<i>L</i> _{EMS}	Whether the firm established environmental management system (EMS)						
<i>L</i> _{FB}	Whether the firm has special environmental branch						
<i>L</i> _{ISO 14000}	The current status of the firm's ISO 14000 authentication						
<i>L</i> _{CPA}	The current status of cleaner production audit						
<i>L</i> _{ET}	Whether the firm provides environmental training to its employees						
<i>L</i> _{CI}	Whether the firm has environmental contingency instrument in corporations						
<i>L</i> _{EPS}	Whether the firm knows the environmental problem of its suppliers						
<i>L</i> _{ERS}	Whether the firm meets environmental requirements of its suppliers						
<i>L</i> _{ECs}	Whether the firm had environmental cooperation with its suppliers						
<i>L</i> _{RB}	Whether the firm recycles its byproduct						
<i>L</i> _{TI}	Will the firm conduct technical innovation, if it can receive governments' support?						
<i>L</i> _{AEPD}	Will the firm have environmental protection devotion in the future?						

pressure and community pressure affecting the performance, respectively. In our econometric exercises, we can then determine how much each of these factors can explain the applied environmental management performance indicator.

This paper defines two characteristics of firms (**A**): (1) financial status (**A_F**) measured by the ratio of net income to total assets, and (2) firms' size (**A_S**) measured by the firms' assets. When examining the link from financial status to environmental management, the analysis avoids using current financial status, since contemporaneous financial status and environmental performance are probably jointly determined. Instead, the analysis uses lagged financial status, which is considered as predetermined [44]. Thus, lagging financial status avoids any endogeneity problem. Moreover, one would expect a lag between the generation of financial resources and the ability to invest in ways of engaging in environmental management initiatives.

Regarding non-compliance sanctions (**R**), the more waste a firm discharges, the local EPB will give it a higher inspection rate. On the other hand, if a large firm was caught for excessive discharge, it would be penalized more money according to its flow. Therefore, in this case heavy pollution firms suffered higher non-compliance sanctions and regulatory pressure. We used effluent fee as a proxy variable to measure non-compliance

sanctions. The effluent fee was calculated based on the discharge of both chemical oxygen demand (700 Yuan per ton) and sulfur dioxide (600 Yuan per ton).

In the survey, we would use proxy variable to measure judicial litigation from accidents and damages to communities (C). In this paper we used population density around the firms as a proxy variable of the judicial litigation from accidents and damages to communities. The population density was sorted to five categories from low (800 persons per square kilometer or less) to high (1600 persons per square kilometer or more).

To declare market incentives (M), we examined the motivated pressures from purchasers (M_P) according to the environmental requirement from supply chain purchasers, as well as pressures from customers (M_C) by asking whether engaging in environmental management would increase firms' green image, with 0 and 3 denoting "not at all important" and "very important", respectively.

4.2.4. Econometric model

According to the above discussion, the following regression equation captured the functional relationship between the overall environmental management performance and the noted explanatory variables.

$$EMP = c + \beta_1 R + \beta_2 C + \beta_3 M_P + \beta_4 M_C + \beta_5 A_F + \beta_6 A_S + \varepsilon \tag{2}$$

here ε represents the error term and c is the constant. EMP represents the environmental management level. R represents regulatory pressure. C represents judicial litigation from accidents and damages to communities. M_P and M_C represent the incentives from purchasers and customers. A_F and A_S , respectively, represent a firm's financial status and size.

We conducted robust regression analysis to identify the determinant factors engaging firms in environmental management. Robust regression analysis using M estimation methods, through iterative reweighting, effectively reduces the influence of outliers and ensures the reliability of the results. Robust regression can be used in any situation in which you would use OLS regression.

5. Results and discussion

5.1. Statistical summary of regression variables

Table 2 summarizes the regressors that shape corporate environmental management performance. The average effluent fee is 14,086.17 Yuan, which represented the regulatory pressure. The average population density contains about 1000 people per square kilometer. The market pressure indicated that 22% of the firms' supply chains had environmental requirements and firms think that the environmental performance was to some extent important to their competition. It also included information on firms' characteristics. The average value was 7,857,000 Yuan and the average finance status was 9.9% of net income to total assets.

Table 2
Summarization of the dependent variables

Variables	Obs.	Mean	Std. dev.	Min.	Max.
R	89	14,086.17	25,102.03	21	157,978
C	89	2.08	1.03	1	5
M_P	89	0.22	0.42	0	1
M_C	89	3.08	1.05	1	5
A_F	89	0.099	0.11	-0.005	0.8014
A_S	89	593.61	521.41	16	1986

5.2. Overview of corporate environmental management performance

Fig. 2 and Table 3 provides the indicators which measured environmental management performance. The table showed that environmental management system level of sample firms was about 3.36, and 75% of the firms had a special branch for environmental management. Furthermore, ISO 14000 authentication and cleaner production audit scores were 2.22 and 2.08, respectively³ Only 8.99% of firms had conducted ISO 14000 authentication and 23.6% of firms had conducted cleaner production audit. Firms (86.5%) provided environmental training to employees and 98.9% of firms had emergency measures. Most firms (75.28%) knew only a few of the suppliers' environmental problems and a few (10.11%) of their environmental requirements. Only 43% of firms had environmental cooperation with their suppliers and 21.5% of firms recycled their byproducts. Firms (95.5%) would carry out technical innovation if they could receive governments' support and 84.2% of firms would increase environmental investment.

According to individual indicator values, the final average level of environmental management performance was 14.53 of total 24. Most firms have scores of 13 (12.36%), 14 (10.11%), 15 (20.22%) and 16 (11.24%). The distribution of EMP could pass the test of normality (Fig. 3). According to the survey data, the environmental management performance in Wujin county is still at a relatively low level.

5.3. Regression results

We divided our regression into two steps. We first conducted our regression analysis not including firms' characteristics (A) as regressors in order to examine all external pressures, and then include firms' characteristics as regressors so as to examine the integrated effects of both external pressures and firms' characteristics.

5.3.1. Effects of external pressures

Estimation results which omitted both financial status and size variables were shown in Table 4. The model provides a robust fitting to the data with adjusted $R^2 = 0.4765$. The discrete variables show shifts in the function of the relationship

³ China has a relatively high number of ISO 14000 registration companies, though the average number in a single region may not be that high.

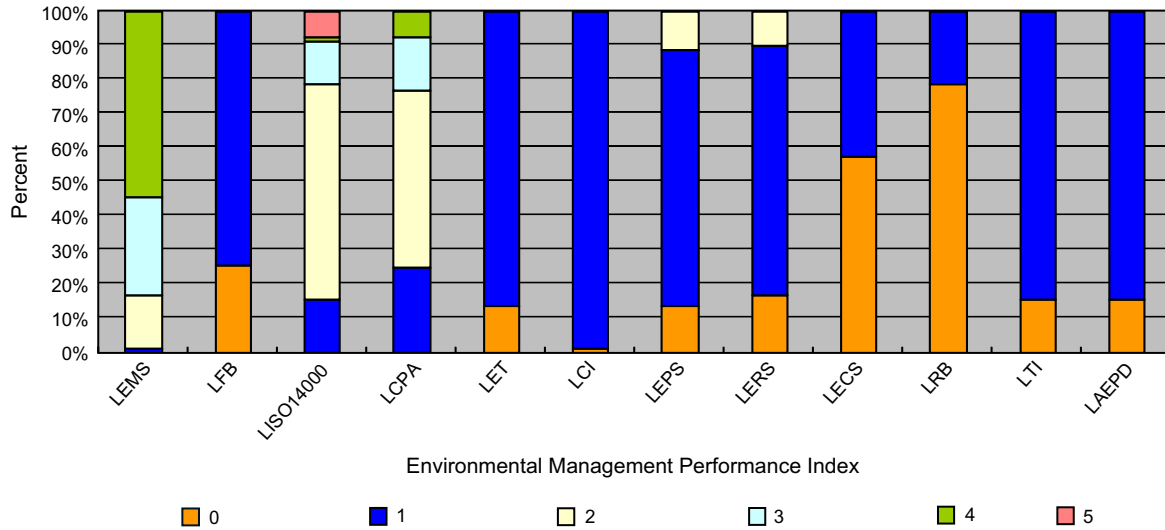


Fig. 2. Results of environmental management performance indicators.

between EMP and the continuous variables over the medium values.

The results indicated that regulatory pressure was insignificant to shape firms to engage in environmental management initiatives. It would be different from the results of other scholars, who indicated that regulatory pressure was the key determinant factor of compliance [14,45]. Other scholars' studies usually focused on the relationship between regulation and regular compliance. Environmental regulation is important and a powerful factor for firms to comply with environmental standards and policies. However, regulation's stimulation may be reduced as long as firms have complied with basic requirements of local environmental standards and other environmental laws. In this case study area, environmental management level was at a relatively higher level when GDP per capita was over US\$ 5000. Regular compliance was a basic requirement for firms in the region. On the one hand, local governments were pushing harder for better environmental quality due to increasing demand from the public. On the other hand, enterprises must portray green images to gain advantages in a very competitive market as most upstream and downstream partners of the supply chains have international background. Therefore, regular compliance indicator such as levy level which was used in this analysis did not impose significant effect on the overall environmental management level defined in this paper, which includes not only basic environmental requirements, but also voluntary solutions such as ISO 14000 authentication.

On the contrary, community pressure had significantly positive effect on corporate environmental management performance. People in Wujin had recognized the importance of protecting the environment and demand for a better environment. Furthermore, most owners have local connections. Wujin EPB also had established some channels such as information disclosure program in helping residents obtain corporate environmental information. The residents could complain by letter

or interview about infringements on the people's environment-related rights. Therefore, the potential threat from residents shaped firms to engage in environmental management initiatives. Firms in the area of higher population density would have higher pressure and would like to achieve better environmental management performance.

The effects of market pressure from supply chain purchasers and customers were also significant. Firms would improve environmental management performance if there were environmental requirements from the supply chain purchasers and customers. Supply chain pressure had been proposed in many other studies as a possible or even probable driver of corporate sustainability engagement. This involved firms that have already implemented formal approaches to environmental management and/or social responsibility, requiring their suppliers to provide evidence that they were also actively improving their environmental and/or social performance. On the other hand, the development of sustainable consumption made most firms desire to present a "green" image to consumers to

Table 3
Summarization of corporate environmental management performance indicators

Indicators	Obs.	Mean	Std. dev.	Min.	Max.
L_{EMS}	88	3.36	0.7905	1	4
L_{FB}	87	0.75	0.4372	0	1
$L_{ISO\ 14000}$	89	2.22	0.9972	1	5
L_{CPA}	89	2.08	0.8501	1	4
L_{ET}	89	0.86	0.3435	0	1
L_{CI}	89	0.99	0.1060	0	1
L_{EPs}	89	0.98	0.4995	0	2
L_{ERS}	89	0.93	0.5178	0	2
L_{ECS}	89	0.43	0.4974	0	1
L_{RB}	79	0.22	0.4136	0	1
L_{TI}	89	0.96	0.2084	0	1
L_{AEPD}	89	0.84	0.3661	0	1
EMP	89	14.53	2.9236	8	22

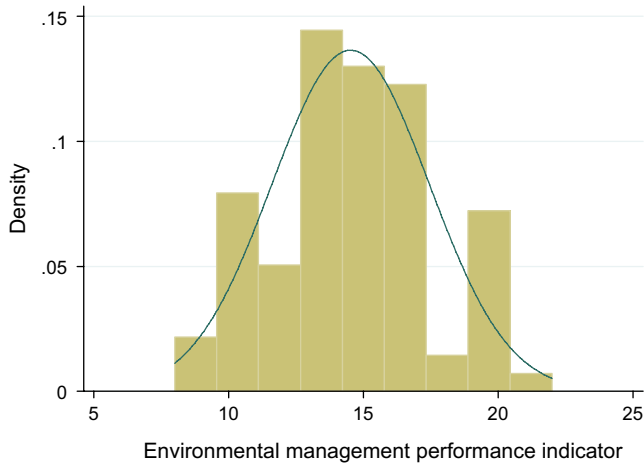


Fig. 3. Distribution of environmental management performance (EMP) ($F = 0.9450$, and could pass the test of normality).

obtain competitive advantages. Thus, market pressure presented a significantly positive effect on corporate environmental management performance.

5.3.2. Effects of firms’ characteristics

In the second regression, we included the effects of firms’ characteristics on environmental management performance. The results were also shown in Table 4. The model EMP-2 provided a higher robust fitting to the data, with adjusted $R^2 = 0.6692$ in the final form, than the respective R^2 of 0.4765 estimated in the form EMP-1. As size and financial status were continuous variables, their coefficients were direct elasticity values.

The results showed that firms with larger scale and better financial status would have better environmental management performance, but the financial status could not pass the t -test. It showed that larger firms, either faced sanctions or wished to avoid them, tended to adopt a greater number of environmental control procedures. The size results confirm most of the

hypothesis put forward in the previous section about plausible influence of these variables, assuring results found in other studies. As we can see in Table 4, size had quite a small elasticity in the model with 0.00036. In other words, 1% increase in the number of employees would motivate 0.0036% increase in the index of environmental management performance.

As the samples in our research were all chemical manufacturing firms and privately owned, the research did not examine the difference of environmental management performance in different industrial sectors and ownerships.

While compared to the first model, other dependent variables (C , M_P and M_C) in model-2 were still significant. But the coefficients in model-2 were smaller than model-1.

6. Conclusions

This paper has sought to identify the determinant factors in engaging firms in environmental management initiatives. The paper differentiated firms’ environmental management performance with a constructed index system. A higher index reflects better environmental management performance. We performed two regression models to explain the impact of formal and informal instruments on the adoption of environmental management initiatives. The paper also analyzes the impact of firms’ characteristics on their environmental management performance. Data were taken from the authors’ survey of Wujin county’s 176 firms, of which 89 firms responded.

The results show that pressures from supply chain and customers, and the community play significantly positive roles in engaging firms in improving environmental management performance. Policy makers should pay more attention to the use of both market and information instruments to engage firms in environmental management. Creating mechanisms that facilitate local communities to access more information about the firms’ environmental performance and thereby add complementary efforts on enforcement, can be accomplished with low-cost initiatives, such as creating an inventory of pollution release and a list of best or worst firms according to specific parameters of compliance status. In reality, this has been partly achieved by the enterprise environmental information disclosure program implemented in Jiangsu Province and will be enhanced when the recently passed “Decree on environmental information disclosure (Trial)” by SEPA is formally implemented from May 1, 2008.

However, the results also show that pressure from the regulatory system does not show significant effects on environmental management performance. Other researchers mentioned that the conventional enforcement of regulation was weak in China [46,47]. Current emission fees and fines are often ‘too low’ in China. The emission fee is only 50% of the cost of pollution control facilities and operations, with some projects being even less than 10% of the costs of pollution control [48]. Thus, current environmental regulation cannot promote firms to engage in further environmental initiatives. Most firms will prefer to pay for the emission fee and fine rather than to promote environmental management performance. Our

Table 4
Robust regression estimation of environmental management performance, by the determinant factors

Variables	Omit firms’ characteristics	Include firms’ characteristics
	EMP-1	EMP-2
R	8.57×10^{-7} (0.09)	-6.92×10^{-6} (-0.94)
C	1.19*** (4.89)	0.30** (2.29)
M_P	1.41** (2.51)	1.04** (2.29)
M_C	0.90*** (3.73)	0.36* (1.74)
A_F	—	0.10 (0.06)
A_S	—	0.0036*** (7.12)
c	8.98*** (12.19)	10.54*** (15.78)
Number of obs.	89	89
F	0.0000	0.0000
Adjusted R^2	0.4765	0.6692

Higher value of dependent variable reflects better environmental management performance.

Robust t -statistics in parentheses.

*Significant at 10%; **significant at 5%; ***significant at 1%.

findings imply that a regularly complied firm may be less sensitive to ordinary levy and fine. However, if levy fee is increased to a certain higher level, which may affect its economic performance, it could again make efforts to comply with stricter regulations. At the current stage, the pressure from regulatory system may be overshadowed by higher pressures from market competition and embedded social network in the study area when most owners are from the same region. However, this assumption should be examined in the following studies, especially when local governments are issuing stricter regulations on chemical and textile industries, such as stricter emission standards. Also, a stricter fee system may still work to some extent.

In addition, firms with larger scale will be more active in improving environmental management performance. Thus, the government should pay more attentions to small- and medium-sized enterprises (SMEs), which have been neglected to some extent due to local EPB's weak capacity. More financial and technical support should be provided to encourage SMEs to improve environmental management performance. In addition, SMEs should be given more regular inspections.

Finally, it should be pointed out that this study has examined only the limited factors which will influence firms' environmental management performance. Our indicators of environmental management performance also need more discussion. A later research will include more factors and examine dynamic changes of environmental performance in order to find out the exact factors that engage firms in environmental management. We also hope this research will encourage other researchers to conduct similar studies in developing countries and regions to determine whether the results we obtained are idiosyncratic to Wujin or not.

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