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Firm's Environmental Expenditure, R&D Intensity, and Profitability

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Abstract: In order to live up to its environmental responsibility, a firm makes an environmental expenditure to reduce its pollution emissions. Then, an important question is what impact the environmental expenditure has on the firm's profitability. In this paper, we first propose and test a hypothesis that the more environmental expenditure the firm makes, the less profitability it enjoys, i.e., there is a negative relationship between the firm's environmental expenditure and its profitability, more specifically its return on assets (ROA). We go further to suggest and test the second hypothesis that the more R&D-intensive the firm is, the lower the "negative impact" of the environmental expenditure on the firm's profitability is, i.e., the firm's R&D intensity moderates the negative relationship between firm's environmental expenditure and its profitability. A significant implication is that since it has to spend money on reducing its pollution emission, the firm should also enhance its innovation capability. That is, by investing in its R&D, the firm can mitigate the negative impact of environmental expenditure on its profitability. In order to test the hypotheses, we collect financial data and carry out panel regression analyses. The analysis results support our hypotheses that there is a negative relationship between the firm's environmental expenditure and its profitability and that the negative relationship is moderated by the firm's R&D capability represented by its R&D intensity.

Keywords: environmental responsibility; environmental expenditure; ROA; R&D intensity

1. Introduction

What is the ultimate goal of a firm? This has been an essential question in economics and business alike. In the more traditional or classic economics, the answer could have been simpler, i.e., it is the profit! However, over the years, the quintessential position of profitability as the vital objective of the firm has been challenged, mainly due to fundamental changes in the market, including consumer behavior and governmental regulation for the environment. That is, as global economic development accelerates, both consumers and governments call for more effort from the firm to protect and improve the environment. Such a demand, over time, has become a strong request for the firm to behave more ethically. It is no longer an option, but a must for the firm to be more proactive not only in the environmental issues, but also in the ethical and social agendas. As a result, corporate social responsibility (CSR) is now regarded as a fundamental basis for the firm's competitiveness [1] in the market. As a key dimension of CSR, corporate environmental responsibility (CER) has emerged as an important factor to boost the firm's competitiveness [2], not just as a burden or constraint on its profitability. Since the consumer's as well as government's awareness of the environment is rapidly increasing, the firm will have to make an effort that goes beyond simple legal requirements or obligations [3,4].

As a concept more encompassing and comprehensive than CSR, therefore, sustainability has become the top priority not only in government, but also in business. As part of the sustainability initiative, environmental responsibility is still one of the key strategic areas for business. In order to

live up to its environmental responsibility, a firm must make an effort to improve the environment surrounding its business activities. Such an effort involves investing in measures to reduce or eliminate harmful pollutants, e.g., by making an environmental expenditure for such measures. However, there is a dilemma facing the company. On the one hand, the company acknowledges that it should make environmental expenditures to solve environmental problems. On the other hand, it is well aware that increasing its commitment to environmental responsibility, i.e., making more environmental expenditure, implies compromising its profitability. After all, the company is not a charity organization. Can the company overcome the tradeoff between environmental responsibility and profitability? In order to answer the question, we first want to understand what impact the environmental expenditure has on the firm's profitability.

Then we further explore whether it is possible for the firm to find ways to overcome the dilemma. We put forth that the firm's innovation capability might shed light on this question. Eiadat et al. (2008) argued that there is a positive relationship between environmental innovation strategy and firms' business performance [5]. In addition, Lee et al. (2015) argued that environmental R&D investment to reduce carbon emission has a positive effect on firm's performance. Extrapolating a plausible link between firm's R&D capability and performance [6], we endeavor to test whether and how the firm's R&D capability enables it to mitigate the tradeoff relationship between environmental spending and profitability. We believe that only when the firm is capable of dealing with the tradeoff effectively, can it make an earnest effort to improve the environment in a sustainable way.

We structure the paper as follows. Section 2 reviews the relevant literature, especially with respect to the environment and R&D. Based on the literature review, we develop hypotheses in this section. Then, in Section 3, we discuss the research design, focused on the data, with which we test the hypotheses. In Section 4, we carry out the regression analysis and report its results to support the hypotheses. We also explain what extra tests we conduct to ensure the validity of our analysis. Finally, we discuss the analysis results and suggest key managerial implications. We conclude the paper by suggesting promising future directions for this line of research.

2. Literature Review and Research Hypotheses

2.1. Literature Review

As the public is increasingly concerned about the environment, the government requires business to take more responsibility for resolving environmental problems [7–10]. For instance, the government puts pressure on firms to make more environmental expenditure. Although this is in agreement with the respectable objective of improving the environment, the firm faces a dilemma here, since environmental expenditure might drastically increase its production costs, such as material and electricity costs, and negatively affect its profitability [11,12]. Worse than that, excessive environmental expenditure could crowd out the firm's productive investment in innovation and thus reduce its efficiency to a great extent [5,13]. For instance, Eiadat et al. (2008) argued that the ever-growing demands on firms to protect the environment could increase capital and labor cost, divert management attention, and crowd out productive investments [5].

Is there a way out of this impasse? Studies in the literature show mixed results. Some of them indicate that there is a strong negative relationship between government's environmental regulation and firm's financial performance, while others hint at a possibility of a positive relationship [14–18]. For instance, Sueyoshi and Goto (2009) found that the environmental protection expenditure of US electric utility firms decreased their financial performance [14]. On the contrary, Porter and van der Linde (1995) argued that the trade-off between government environmental regulation and firms' business performance is probably due to a static approach to the problem. They further put forth that if they carry out the analysis through a dynamic framework, which embraces the possibility of fostering innovation, then the firm could reduce its production cost [15]. Similarly, Al-Tuwaijri et al. (2004) hinted that good environmental performance is significantly associated with good economic

performance [16], while Brolund and Lundmark (2017) found that the regulation about environmental pollutants could drive firm's productivity improvements [17]. In a similar vein, Ashford and Hall (2011) suggested that the sustainable development requires stimulating revolutionary technological innovations through environmental, health, safety, economic, and labor market regulations [18].

Although we doubt there is a "direct" positive relationship between regulation and performance, we think that it is possible for the firm to find ways or measures to enable it to mitigate the tradeoff relationship between environmental expenditure and profitability. We further propose that one such measure is related with the firm's R&D, which can enhance its innovation capability. That is, R&D does not have to be specifically related with the environment. Investment in R&D in general can increase the firm's ability to identify and solve difficult managerial problems, one of which is certainly linked with environmental issues [19–22]. For example, Zhang and Xu (2016) postulated that general technological progress mostly explains the improvement in overall carbon productivity, i.e., the productivity of methods to improve the environment [19].

In essence, we postulate that the firm's general R&D capability can help it to deal with environmental problems efficiently, i.e., to enhance the effectiveness of its environmental expenditure. Therefore, the firm's R&D capability moderates the negative impact of the environmental expenditure on its profitability, i.e., the larger the R&D intensity, the less negative the effect of the environmental expenditure on the firm's return on assets (ROA).

There are a few distinctive differences between our paper and other references in the literature. Although there are references that explore the relationship between environmental expenditure and firm performance, most of them use subjective or qualitative approaches such as case studies. On the contrary, we endeavor to prove our hypotheses objectively and systematically by collecting and analyzing actual data from manufacturing companies.

Another significant contribution our research makes to the literature is concerned with enriching the scope of research. That is, we include the firm's R&D as a moderating variable in analyzing the relationship between environmental expenditures and firm performance, while most of the previous studies were focused on the simple correlation between the two.

2.2. Research Hypotheses

Based on the literature review, we develop our research hypotheses. We already argued that facing mounting pressure from not only the government but also the public, firms are increasing their environmental expenditure. Environmental expenditure includes all expenditures on environmental protection to prevent, reduce, and control environmental aspects, impacts, and hazards, in addition to disposal, treatment, sanitation, and clean-up expenditures. As such, the firm can expect that by increasing its environmental expenditure, it can better respond to government regulations and public requirements. However, the problem is that increasing the environmental expenditure might dampen the firm's profitability. There are several explanations for this detrimental consequence. If the firm decides to pass through the environmental expenditure to its product price in the competitive market, its sales might go down, as does its profit. Moreover, if the firm allows the environmental expenditure to crowd out other productive investments for innovation and efficiency improvement, it reduces the firm's long-term potential to earn profit. Thus, we propose the first hypothesis.

Hypothesis 1. *There exists a negative relationship between the firm's environmental expenditure and its profitability, i.e., ROA.*

In effect, Hypothesis 1 says that the more the environmental expenditure the firm makes, the less the firm's profitability, as reflected in ROA.

Is it possible for the firm to overcome the trade-off relationship between the firm's environmental expenditure and its profitability? We suggest that if the firm has a strong capability to identify and solve diverse managerial problems in creative ways, it can at least mitigate such a negative relationship.

This capability does not have to be specifically related with the environmental aspects only. In fact, it can be a broad or general competence to innovate, which is closely linked with the firm's overall R&D capability. For instance, the firm's general R&D capability enables the firm to find an efficient way to use raw materials and thus reduce costs related with raw materials and waste disposal. It can further lead the firm to find more productive ways to convert waste into saleable products and thus increase its profit. It is also possible for the firm to develop new methods to cut pollution emissions without affecting productivity. All these imply that the firm with higher innovation capability can reduce negative effect of the firm's environmental expenditure on its financial performance (ROA). Assuming that the firm's innovation capability is well represented by its R&D intensity, we postulate the second hypothesis.

Hypothesis 2. *R&D intensity moderates the negative relationship between the firm's environmental expenditure and its profitability.*

That is, the larger the firm's R&D intensity, the less the negative effect of the firm's environmental expenditure on its profitability.

3. Research Design

We recapitulate the research questions of our research. First, there is a negative relationship between the firm's environmental expenditure and its profitability. However, the negative relationship is moderated by the firm's R&D. That is, the larger the firm's R&D intensity, the less negative the impact of the environmental expenditure on its ROA. In order to test the hypotheses, we carry out regression analyses with empirical data, which are the essential part of our research design.

To test the hypotheses, we collect the relevant firm level data from two data sources. Environmental data, such as environmental expenditure, is taken from the Thomson Reuters Asset 4—ESG (environmental social governance) database. We next merge the environmental data with the financial data obtained from the Compustat database. Finally, our sample consists of 100 American manufacturing firms (SIC 2000–3999), which offer unbalanced panel data; see Table 1 for the composition of industries included in the sample. We use the manufacturing firms because the manufacturing sector is the one that provides measurable data related with the environmental problems such as pollutants emitted during the production process. Finally, we get 680 observations from 2003 to 2016.

Table 1. Sample composition.

Industry	SIC Code	Number of Firms
Food & Kindred products	20	5
Tobacco products	21	1
Paper & allied products	26	5
Chemical & allied products	28	39
Petroleum & Coal products	29	4
Rubber & Miscellaneous Plastics products	30	2
Primary metal industries	33	7
Fabricated metal products	34	5
Industrial machinery & equipment	35	3
Electronics & other electric equipment	36	9
Transportation equipment	37	10
Instruments & related products	38	9
Miscellaneous manufacturing industries	39	1

The dependent variable is Return on Assets (ROA), the firm's net income divided by its total assets, which is a common measure that can represent the firm's financial performance. As a key independent variable, we use the environmental expenditure normalized by the firm's sales; this is defined as all expenditures on environmental protection to prevent, reduce, and control environmental aspects, impacts, and hazards. It also includes disposal, treatment, sanitation, and clean-up expenditures.

It reflects how much resources the firm is investing for the environment. Another key independent variable is the firm's R&D intensity, which is also a moderator in our model. R&D intensity is calculated as the firm's R&D expenditure divided by its total sales.

In order to eliminate any spurious effects, we include several control variables in our model. By doing so, we hope to mitigate the possible "omitted variable bias" in our focal effects on ROA [23]. Based on the relevant literature [24,25], we use the control variables such as firm size, book to market ratio, book leverage, and sales growth. Since the literature shows a potentially strong relationship between the firm size and its financial performance [26], we include the logged sales in the analysis to control the firm size effect on ROA. We also include the book to market ratio and sales growth ratio so as to control the firm's growth potential in the future, which can affect ROA. Book to market ratio is calculated as the book value of the firm divided by its market value [27]. Sales growth is the change in sales from last year divided by last year's sales. We use the book leverage to measure the debt level relative to the assets [28], since the debt level can potentially affect the firm's financial performance. We also take into account the industry fixed effect on the two-digit SIC code and the year fixed effect. We winsorize all variables to handle outliers at the 1% level in each tail of the distribution [29].

See Table 2 for more detailed explanations about the variables and their measurements.

Table 2. Definition of variables.

Variable	Definition	Measurement
ROA (return on assets)	Net income divided by total assets	$\frac{\text{Net income}}{\text{Total assets}}$
Environmental expenditure	All expenditures on environmental protection to prevent, reduce, and control environmental aspects, impacts, and hazards, in addition to disposal, treatment, sanitation, and clean-up expenditures	$\frac{\text{Environmental expenditure}}{\text{sales}}$
R&D intensity	R&D expenditure divided by sales	$\frac{\text{R\&D expenditure}}{\text{sales}}$
Firm size	Size of the firm	Ln(sales)
Book to market	Book value of the firm divided by its market value	$\frac{\text{book value of the firm}}{\text{market value of the firm}}$
Book leverage	Debt level relative to assets	$\frac{\text{Debt}}{\text{Asset}}$
Sales growth	Change in sales from last year divided by last year's sales	$\frac{\text{This year's sales} - \text{previous year's sales}}{\text{previous year's sales}}$

4. Regression Analysis and Results

To test the hypotheses, we analyze the data using the panel regression analysis. Our data consists of the firm's level unbalanced panel data, and we have to figure out which model is appropriate between the fixed effect and the random effect model. Therefore, we conducted the Hausman test. The p-value of the test is significant ($p < 0.001$), suggesting that the fixed effect model is more appropriate for our research. Tables 3 and 4 report descriptive statistics and pairwise correlations. Correlation between any two different variables is not high, the biggest number being −0.3106.

Table 3. Descriptive statistics.

Variable	Mean	S.D.	Min	Max	Skewness	Kurtosis	Measurement
ROA	8.028471	5.539482	−11.99	21.96	−0.478219	4.71942	$\frac{\text{Net income}}{\text{Total assets}}$
Environmental expenditure	5.539262	7.414238	0	34.49465	2.137297	7.35644	$\frac{\text{Environmental expenditure}}{\text{sales}}$
R&D intensity	0.038613	0.048784	0.000657	0.239314	2.208911	7.72117	$\frac{\text{R\&D expenditure}}{\text{sales}}$
Firm size	16.21708	1.283077	14.08209	19.64909	0.561276	2.87126	Ln(sales)
Book to market	0.352719	0.240850	−0.20262	1.158188	0.864270	4.12357	$\frac{\text{book value of the firm}}{\text{market value of the firm}}$
Book leverage	0.263393	0.140714	0	0.632203	0.540432	3.09426	$\frac{\text{Debt}}{\text{Asset}}$
Sales growth	0.021411	0.143468	−0.46668	0.463966	−0.430425	5.27241	$\frac{\text{This year's sales} - \text{previous year's sales}}{\text{previous year's sales}}$

Table 4. Correlation table.

	1	2	3	4	5	6	7
1. ROA	1						
2. Environmental expenditure	−0.1617 ***	1					
3. R&D intensity	0.1579 ***	−0.2077 ***	1				
4. Firm size	0.1101 ***	−0.1145 **	0.1824 ***	1			
5. Book to market ratio	−0.2796 ***	0.0483	−0.1212 ***	0.0474	1		
6. Book leverage	−0.1474 ***	−0.0367	−0.1318 ***	−0.1341 ***	−0.3106 ***	1	
7. Sales growth	0.1879 ***	−0.0663 *	0.0051	0.0493	−0.0091	−0.0472	1

Note: Significance at the 10%, 5%, and 1% is indicated by *, **, and ***, respectively. All significance tests are two tailed.

Our regression equation is defined as follows.

$\mathrm{ROA}_{it} = \alpha + \beta_1 Environmental\ \ expenditure_{it} + \sum \beta_{2i} C_{it} + \sum \beta_{3i} I_i + \sum \beta_{4i} Y_t + \varepsilon_{it}$, where i represents firm i, t time, C control variable, I industry dummy, Y year dummy, and ε error term.

ROA_{it} represents the ROA and $Environmental\ expenditure_{it}$ the environmental expenditure of the firm i in year t, $\sum \beta_{2i} C_{it}$ a set of control variables, $\sum \beta_{3i} I_i$ and $\sum \beta_{4i} Y_t$ dummy variables for the industry fixed effect and the year fixed effect respectively.

Regression results are reported in Table 5: we use Model 1 to test Hypothesis 1 and Model 3 to test Hypothesis 2.

Hypothesis 1 predicts a negative relationship between firm's environmental expenditure and ROA. As Model 1 in Table 5 shows, there is indeed a significant negative relationship between firm's environmental expenditure and ROA. This result persists in Model 2, where R&D intensity is included as an independent variable. The regression result strongly supports that the more the environmental spending, the less the company's profitability. It is reasonable since the firm's environmental expenses put an extra burden on the firm, *ceteris paribus*.

Hypothesis 2 explores whether the firm's R&D can mitigate the negative relationship between its environmental expenditure and profitability. We have already discussed why the R&D might reduce the negative impact of environmental expenditure on firm's profitability. By engaging in R&D activities, the firm can increase its managerial capability, which enables it to deal with environmental issues more efficiently and thus solve environmental problems with less cost than without such R&D. The regression Model 3 in Table 5 supports Hypothesis 2 significantly. That is, the regression coefficient of the interaction term between the firm's R&D intensity and environmental expenditure is significantly positive while the regression coefficient of environmental expenditure is still negative, implying that given the same level of environmental expenditure, the negative impact of environmental expenditure on the firm's profitability decreases, as the firm increases its investment in R&D. In effect, the firm's R&D intensity moderates the relationship between environmental expenditure and profitability.

Table 5. Regression results.

Variable	Dependent Variable: ROA		
	Model 1	**Model 2**	**Model 3**
Environmental Expenditure	−0.139185 *** (0.0452557)	−0.1361957 *** (0.0457095)	−0.2186991 *** (0.0657999)
R&D intensity		2.340168 (8.26708)	−5.447871 (7.369195)
R&D intensity * Environmental expenditure			3.812526 ** (1.567257)
Firm size	0.3442388 (0.2791451)	0.3120452 (0.321167)	0.293389 (0.3318147)
Book to market ratio	−7.917967 *** (2.152678)	−7.884958 *** (2.177356)	−7.858662 *** (2.161823)
Book leverage	−9.353201 *** (2.183297)	−9.2118 *** (2.095909)	−9.636965 *** (2.157472)
Sales growth ratio	6.272927 *** (2.203705)	6.287539 *** (2.224334)	6.720534 *** (2.211378)
Observation	680	680	680
R^2	0.2728	0.2731	0.2866
Year fixed effect	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes

Note: Significance at the 10%, 5%, and 1% is indicated by *, **, and ***, respectively. All significance tests are two tailed.

In order to strengthen our analysis results, we carry out a few more tests. First, we measure the variance inflation factors (VIFs) to determine whether there exists a multicollinearity issue among the variables. It turns out that the VIFs of our models are below the threshold value 10 [30]. Therefore, we conclude that there is no multicollinearity in our models.

For robustness tests, we conduct an additional regression analysis to see whether the environmental expenditure is truly associated with the firm's ROA. To address this concern, we consider the reverse causality as well as the potential endogeneity issue.

First, as in Dobrzykowski et al. (2016) [31], we use one-year lagged terms for all independent and control variables to deal with the reverse causality issue. In order to use the lagged terms, we need consecutive data. Since we use unbalanced panel data, we remove some data points that do not satisfy this condition. Thus, the sample size is reduced from 680 to 565. As in Table 6, the results essentially remain the same. That is, despite using the lagged variables, there is a significantly negative relationship between the firm's environmental expenditure and its profitability (Model 4 and Model 5). In addition, in Model 6, the regression coefficient of the interaction term between the firm's environmental expenditure and its R&D intensity is significantly positive, implying the R&D intensity moderates the negative relationship between environmental expenditure and ROA.

Table 6. Robustness test results.

Variable	Dependent Variable: ROA		
	Model 4	**Model 5**	**Model 6**
Environmental Expenditure	−0.1417798 ** (0.0588546)	−0.1385791 ** (0.0584085)	−0.2134736 ** (0.0888361)
R&D intensity		2.265453 (8.076122)	−4.738514 (7.727864)
R&D intensity * Environmental expenditure			3.600165 * (2.143999)
Firm size	0.0100527 (0.26573)	−0.0211206 (0.3038663)	−0.0508058 (0.3112379)
Book to market ratio	−9.281094 *** (2.153464)	−9.26051 *** (1.750115)	−9.334336 *** (1.719387)
Book leverage	−6.100204 *** (2.490651)	−5.962588 *** (2.042238)	−6.241607 *** (2.063817)
Sales growth ratio	3.549659 (2.490651)	3.578336 (2.521354)	3.936044 (2.530093)
Observation	565	565	565
R^2	0.2592	0.2595	0.2702
Year fixed effect	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes

Note: Significance at the 10%, 5%, and 1% is indicated by *, **, and ***, respectively. All significance tests are two tailed.

In order to address the potential endogeneity problem, we use an instrumental variable approach, i.e., the two-stage least squares (2-SLS) model. The instrument variable we use for the 2-SLS test is the existence of firm's water efficiency policy. It is a dummy variable about whether the firm has a policy to improve its water efficiency or not. It is reasonable to assume that the firm with a water efficiency policy would spend less for the environmental expenditure. On the other hand, we premise that the existence of water efficiency policy itself does not affect ROA. Therefore, we collect the water efficiency policy data from Asset 4, and carry out the 2-SLS regression analysis.

In the first-stage regression, we set the environmental expenditure as the dependent variable and, as expected, the water efficiency policy has a negative impact on the environmental expenditure at the 5% significance level. As Table 7 shows, in the second-stage regression, the instrumented environmental expenditure is negatively related to ROA at the 5% significance level. Consequently, with the results, we confidently conclude that the firm's environmental expenditure does affect its ROA.

Table 7. 2-SLS test results.

Variable	First Stage	Second Stage
	DV: Environmental Expenditure	**DV: ROA**
Instrumented Environmental Expenditure		−0.4486856 ** (0.2276598)
Water efficiency policy	−3.112962 ** (1.289435)	
Firm size	−0.9167857 (0.6453496)	−0.1382008 (0.4630516)
Book to market ratio	−1.529953 (2.594086)	−8.344199 *** (2.081784)
Book leverage	0.1383635 (4.065547)	−9.381889 *** (2.257462)
Sales growth ratio	−4.939401 ** (2.438336)	5.003054 ** (2.297023)
Observation	680	680
R^2	0.2208	0.1344
Year fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes

Note: Significance at the 5%, and 1% is indicated by **, and ***, respectively. All significance tests are two tailed.

5. Discussion and Conclusions

As environmental issues become more important and government, as well as the public, requires business to do more for the environment, firms are facing an ever-mounting pressure to increase their environmental expenditure. Although they feel forced to spend more on environmental initiatives, firms might be reluctant to increase their environmental expenditure as long as there is a strong negative impact of such an expenditure on the firms' profitability. Our research indeed demonstrates that the more the environmental expenditure, the less a firm's ROA.

Now the firm's dilemma is clear. On the one hand, it should respond to the external pressure to do more by spending more for the environment. On the other hand, it cannot sacrifice its profitability too much. Thus, there is a serious tradeoff issue between improving the environment and preventing its profitability from decreasing extensively.

How can the firm overcome the tradeoff? Our research sheds light on answering the question. A firm's R&D capability might enable the firm to get over the tradeoff and to mitigate the negative impact of the environmental spending on its profitability. We reason as follows. By investing heavily in its overall R&D, not necessarily focused on the environment specifically, the firm enhances its "general" managerial capability, which enables it to identify and solve a wide range of problems, not only managerial in a broad sense, but also environmental.

In sum, we have developed, tested, and confirmed the following two hypotheses. First, there is a negative relationship between the firm's environmental expenditure and its profitability. Second, the negative relationship is moderated by the firm's innovation capability embodied in its R&D. That is, the larger the firm's R&D intensity, the less negative the impact of the environmental expenditure on its profitability reflected in its Return on Assets (ROA).

The key lesson is as follows. Since it is almost impossible for the firm to ignore the pressure from the government and the public to do more for the environment, it should try to accommodate such requests by increasing its environmental expenditure. However, at the same time, the firm should plan to strengthen its innovation capability by investing more in R&D activities, i.e., enhancing its R&D intensity.

This lesson has strategic implications for the firm. It is clear that doing more for the environment is not an option, but a must for the firm. That is, it is almost a constraint. If it cannot violate the

constraint, the firm should be able to find ways to overcome the negative impact of the constraint as much as possible. Our research results imply that to be environmentally responsible is not necessarily to be less profitable. On the contrary, it hints that the firm can be both environmentally responsible and competitive in the market at the same, if it makes a strategic effort to enhance its innovation capacity by investing in the R&D activities. Of course, such an investment might put another financial burden on the firm, at least in the short run. That is why the firm should make a strategic decision, i.e., how to optimally allocate its resources between environmental initiatives and R&D capabilities in the long term. Our research results can help the firm to make such a decision by showing that the R&D capability indeed mitigates the negative effect of environmental expenditures on the firm's profitability.

As alluded to before, our research can make meaningful contributions to the literature, which are quite distinctive compared with other studies in the literature. First of all, we have utilized research methodologies that are more objective and systematic than those adopted by others. That is, we have tested and proved our hypotheses by analyzing actual data, using regression analyses supported by rigorous validity tests: in order to prove the propositions, we have carried out rigorous analyses, using regression analysis methods as well as robustness tests with a large set of actual data.

We have also extended the research scope by including the firm's R&D as a moderating variable in analyzing the relationship between environmental expenditures and firm performance. This research model is quite different from most of the previous studies, which were focused on the simple correlation between the two. Our analysis results support the hypotheses that there is a negative relationship between the firm's environment expenditure and its profitability and that the negative relationship is moderated by the firm's R&D capability represented by its R&D intensity.

Although we believe the research results are very strong, since the analysis is based on a large sample of actual data, there are a few limitations. Our research in this paper shedding light on a broad role played by the firm's R&D in its environmental management, we suggest that future research should focus on more specific areas of R&D, which can directly affect the firm's efforts to improve the environment. For instance, there are diverse R&D activities such as six-sigma teams, process improvement activities, new product innovation activities, basic science research, engineering applications, and the like. It would be an important study to explore which specific R&D activities have a greater impact on the firm's environmental efforts and how. In addition, we believe it is important to identify other possible performance measures in addition to ROA. There are additional interesting questions such as "Is there a significant relationship between environmental expenditure and the amount of pollution emitted by the firm?" Finally, it would be a very productive study to examine whether the research results can vary, depending on the cultural or social contexts where the study is carried out. Is the role of R&D intensity in mitigating the negative relationship between environmental expenditures and profit weakened or strengthened in different cultures? If so, why? These research questions can clarify fascinating future research directions.

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