

Are environmentally friendly firms more innovation-oriented?

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

This study aims to explore the relationship between corporate environmental responsibility and firm's innovation decision. It proposes that firms investing in environmental protection are more likely to have strong dynamic capabilities to proactively respond to the growing environmental awareness and movement, which in turn can trigger their innovation intention. Moreover, building on stakeholder theory, this study also hypothesizes an indirect relationship between firms' environmental responsibility and innovation decision mediated by government support. The hypotheses are tested by analyzing the Chinese Private Enterprise Survey data collected in 2010 and are supported. The theoretical and practical implications of the findings are discussed.

Keywords: Corporate environmental responsibility (CSR); Environmental protection; Sustainable development; Government subsidies; Research and development (R&D); Firm innovation decision

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Table of Contents

LIST OF TABLES	VII
LIST OF FIGURES.....	VIII
1. INTRODUCTION	1
2. LITERATURE REVIEW: CORPORATE ENVIRONMENTAL PROTECTION AND FIRM INNOVATION	3
3. THEORIES AND HYPOTHESES DEVELOPMENT.....	7
3.1 ENVIRONMENTAL PROTECTION IN CHINA.....	7
3.2 CORPORATE ENVIRONMENTAL PROTECTION AND FIRM INNOVATION DECISION	10
3.3 THE MEDIATING EFFECT OF GOVERNMENT R&D SUBSIDIES	12
3.3.1 <i>Corporate environmental protection and government R&D subsidies.....</i>	<i>13</i>
3.3.2 <i>Government R&D subsidies and firm innovation decision.....</i>	<i>14</i>
4. METHODS	16
4.1 DATA	16
4.2 VARIABLES	16
4.2.1 <i>Dependent variable.....</i>	<i>16</i>
4.2.2 <i>Independent variables</i>	<i>16</i>
4.2.3 <i>Control variables</i>	<i>17</i>
4.3 MODELS.....	19
5. RESULTS.....	22
6. DISCUSSION	25
6.1 FINDINGS AND IMPLICATIONS	25
6.2 PRACTICAL IMPLICATIONS.....	27
6.3 LIMITATIONS AND FUTURE RESEARCH.....	28
7. CONCLUSION.....	29
REFERENCES.....	30

List of Tables

Table 1: Variable Definitions and Descriptive Statistics	20
Table 2: Correlation Matrix	21
Table 3: Logit Model Results.....	23
Table 4: Decomposition of the Effects of Environmental Protection Spending on R&D Decision.	24

List of Figures

Figure 1: Hypothesized model	15
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1. Introduction

Organizational performance has been increasingly multi-dimensional. In the 1990s, the triple bottom line (TBL) of corporate performance was conceptualized by John Elkington, who argued that corporate performance should be evaluated with multiple dimensions including economic, social, and environmental performance (Elkington, 1997). How do organizations maintain good performance in all these aspects, given that they have only limited resources, such as financial and human resources, as well as managerial attention? It seems to be obvious that investing in one area – for example social and environmental issues – will impede advancement in others – for example R&D activities. Therefore, it is often a critical strategic decision for firms to selectively allocate their limited resources to competing demands in their businesses.

On the other hand, we also observe successful companies that perform well in multiple domains of activities. They contribute actively to social and environmental initiatives, keep developing new products, optimize business processes, and achieve great financial performance. For example, Starbucks is well known for its continuous efforts in promoting fair trading and the usage of organic green ingredients, and for its contribution to sustainability and environmental stewardship.¹ Starbucks has also been recognized for its innovativeness in product development and packaging

¹ Refer to the website of Starbucks (<https://stories.starbucks.ca/en/stories/2020/5-things-to-know-starbucks-sustainability-commitment/#:~:text=Starbucks%20identified%20key%20areas%20in,for%20ways%20to%20better%20manage>), last visit on Aug 8, 2021

improvement.² One may easily think of a few reasons for Starbucks' outstanding performance in both areas of environmental protection and innovation. For instance, Starbucks is a large public firm and is under close public scrutiny. Facing the pressure to incorporate environment and sustainability considerations in business, it has little leeway if it is to signal corporate goodwill and keep its reputation. In addition, as a well-established firm, Starbucks has stronger organizational capabilities and extensive resources to integrate various organizational activities that would otherwise be competing with one another.

What about smaller firms, especially those in a developing country, where the concerns for the natural environment and the social awareness of environmental protection are still emerging and developing? In that context, how do firms juggle with seemingly competing demands of being environmentally friendly and innovative? To answer this question, we focus our attention on private enterprises in China. Due to the political regime and the transitioning economy, firms in the private sector of China, compared with their state-owned counterparts, are usually of small- and medium-size with limited political and financial resources. Yet, they support more than 80% of the urban employment and are a major driving force of the country's economic development.³ Understanding how private firms deal with the tension between the increasing concerns for environmental issues and the call for

² Refer to the website of Starbucks (<https://stories.starbucks.com/stories/2014/10-starbucks-innovations-of-2014/>), last visit on Aug 8, 2021

³ Refer to <https://www.reuters.com/article/us-china-economy/china-to-offer-more-support-for-private-firms-seeking-market-funds-idUSKCN1MW100>, last visit on Aug 17, 2021

continuous technological innovation may provide us with additional insights of the development path of China's economy.

2. Literature Review: Corporate environmental protection and firm innovation

Corporate environmental responsibility (CER) is a critical dimension of corporate social responsibility (CSR). Much research has discussed the relationship between CSR and firm performance (McWilliams & Siegel, 2000; Surroca et al., 2010), which bears implications for the relationship of our interest, which is the one between CER and firm R&D decision.

A stream of literature, based on attention-based view of organizations, sees CSR as a cost of organizations. Researchers in this camp argue that managerial attention and firm resources are limited, and CSR may distract managerial attention or consume valuable organizational resources that could have been used for other activities – such as innovation – that might generate better economic returns (Friedman, 1970; Gallego-Alvarez et al., 2011; Hillman & Keim, 2001). For example, using a dataset that contains 5,999 Indian firms from 2000 to 2013, Mithani (2017) found that investing in R&D could generate six times the economic return compared to investing in ecological initiatives. This study advocated that managers should allocate valuable firm resources according to a priority ranking of corporate activities that yields different levels of economic return. Similarly, Gallego-Alvarez et al. (2011) also found that CSR (measured by an indicator that whether a firm is listed in the Dow Jones Sustainability Index) and firm's R&D intensity were negatively related; CSR

and innovation activities seemed to compete for organizational resources. Based on this finding, the authors believed that firms could benefit more by spending limited resources on innovation which produces better products that are attractive to customers, instead of engaging in CSR to appear more appealing to their customers. This line of studies suggests a negative relationship between CER and firm innovation performance.

However, another stream of literature suggests the opposite that CER can potentially boost firm innovation performance (Luo & Du, 2015; Porter & Kramer, 2007; Sharma & Vredenburg, 1998). For example, Sharma and Vredenburg (1998) found that good environmental strategies could facilitate the development of organizational capabilities, such as the ability to communicate and collaborate with stakeholders for problem solving, to gain new knowledge, to discover opportunities and to experiment new practices and so on. These organizational capabilities can potentially promote organizational innovation. Porter and Kramer (2007) also found that incorporating CER in business operation and firm strategies could enhance firms' innovation that makes their products and production processes greener.

The inconclusive findings in the literature on the CER-innovation relationship may be due to the predominant focus on innovation performance in the literature, which is often captured by the number of new product introductions or the number of patents granted to measure firm innovation performance (Luo & Du, 2015; Wagner, 2010; Wu et al., 2020). Using outcome-oriented measures of innovation may obscure the mechanism of why and how CER affects firm innovation through firms' decision-

making process and strategy choice. Innovation activities are costly and risky with uncertain return. The process that starts from firms' decision to invest in CER to innovation performance is everything but straightforward and contains much more steps and factors in between, which can determine the final relationship between the two. Firm strategic decision of whether to invest in R&D is one of the intermediate steps. By introducing this factor, we decompose the process from CER to innovation performance into two parts – one that starts from CER to R&D decision, and the other that continues from R&D decision to innovation performance. Given that the relationship between R&D decision and innovation performance is usually positive (Fernandez et al., 2018; Sanchez-Sellero & Bataineh, 2021), one may wonder whether it is possible that the inconsistency in the current literature may be due to the lack of understanding of the relationship between CER and R&D decision. It is the focus of this study. By focusing on firms' intention to invest in R&D, rather than innovation performance, as an outcome of CER, this study can help deepen our understanding of how firm CER may affect innovation performance.

Apart from examining the direct relationship between CER and firm innovation performance, researchers have also investigated some boundary conditions of this relationship to examine whether and how it varies in different contexts. For example, they find that CER has stronger effects on firm innovation performance when firms are located in economically more developed regions with a higher level of marketization (Ji et al., 2019), when firms are more visible to the public (Gao et al., 2017; Wu et al., 2020), or when firms are family-owned (Wagner, 2010).

Furthermore, the mechanisms that connect CER and firm innovation performance have also been explored. Based on stakeholder theory, many studies have argued that firms can gain competitive advantages by satisfying both internal and external stakeholders' needs and incorporating their interests in their business strategies (Mithani, 2017; Pelozo & Shang, 2011). Stakeholder theory claims that stakeholders and firms maintain an exchange relationship, in which the former can provide the latter with critical resources if their concerns and needs are addressed (Freeman, 2010). Firms that engage in environmental protection and sustainable development can better integrate the interests of environmentally mindful stakeholders, such as the local governments and the environmentally enthusiastic customers, into their strategies and as a return get access to new information, knowledge, and other critical resources provided by their stakeholders (Auld et al., 2008; Sharma & Vredenburg, 1998). For example, several studies find that proactive environmental strategies can help firms form meaningful relationships and engage in deep communication with external stakeholders, which allow new ideas, perspectives, and knowledge to flow into firms' product development process, helping them become more innovative (Bin Saeed et al., 2019; Luo & Du, 2015). We test the mediating effect of stakeholder in the relationship between CER and R&D decision. We explore whether local government R&D subsidies mediates the relationship between private firms' CER and their R&D investment intention.

Our study makes two contributions to the literature. First, we focus on R&D investment decision, rather than innovation performance, to examine the effect of

CER. This focus might contribute to deepening the understanding of the relationship between CER and firm innovation by directing attention to a more uncertain (and more interesting) component of the relationship. Second, instead of studying public and large firms with ample organizational resources, we answer our research question in China's private sector, which consists of smaller and more resource-constrained firms. We believe that our empirical context can help to expand our knowledge in the environmental management and innovation literature.

3. Theories and Hypotheses Development

3.1 Environmental protection in China

China's fast economic development since the beginning of economic reform and opening up in 1978 has been at a cost of the natural environment. The continuous high GDP growth was accompanied by severe pollution of the air, the water, and the soil. Although the first guideline of environment protection was officially issued by the State Council in 1973 and then environment protection was constitutionalized in 1978, the economic development in China had not been environmentally sustainable for many years. However, the awareness of environment protection and sustainable development has been increasing over time, especially since China joined the World Trade Organization (WTO) in 2001. Being a member of the WTO to a large extent intensifies China's international trade, which imposes huge pressure on China to pay more attention to environmental protection. During the last two decades, China has tightened up its environmental laws and regulations to meet international standards and to reduce the environmental impact of businesses within the country. The

emphasis on environmental protection in China's legal system has been largely intensified, as the result of the two revisions of the Constitution in 1982 and 2018 (Zheng & Wang, 2018). In 2015, the revised version of Environmental Protection Law, which was first promulgated in 1989, took effect, and it is regarded as the strictest environmental law in history since the founding of the PRC in 1949. Environmental protection also plays an increasingly important role in all aspects of social and economic development. Detailed and measurable goals related to sustainability and environment, rather than general and vague principles, was incorporated in 5-year plans of the country for the first time at the beginning of the 11th plan in 2006. The plan included goals of reducing energy consumption per unit of GDP by 20%, reducing water consumption per unit of industrial added value by 30%⁴, and cutting chemical oxygen demand, an important measure of the degree of water pollution, by 10%, and so on (Ma, 2010). Since then, goals and guidelines related to environmental protection and sustainable development have been increasingly weighted in the 5-year plans. In addition to strengthening legislative efforts and setting goals and guidelines, the central government of China has also been increasing the financial investment to control environmental pollution. According to the National Bureau of Statistics, the total investment in 2014 was 957.6 billion yuan, which was 8.2 times of the total investment of 116.7 billion yuan in 2001⁵. Furthermore, recent years has witnessed a change in the Chinese Communist

⁴ Refer to Wikipedia: Five-year plans of China (https://en.wikipedia.org/wiki/Five-year_plans_of_China), last visited on August 3, 2021.

⁵ Refer to the webpage of the National Bureau of Statistics of China

Party's governing philosophy, which weakens the emphasis on economic development in the performance evaluation of local government officials of different levels and to a great extent stresses environmental protection. Party cadres' incentive of protecting the environment and promoting pro-environment businesses in their jurisdictions is therefore greatly intensified.

Meanwhile, the awareness of sustainable development and environmental protection is increasingly salient in society. Multiple waves of Chinese General Social Survey (CGSS) show that ordinary people's environmental consciousness – captured by New Ecological Paradigm (NEP) Scale (Dunlap et al., 2000) – significantly increased from 2003, when the first CGSS was conducted, to 2010, in both rural and urban areas across the country (Hong, 2014). Furthermore, in recent years, an increasing number of ordinary people who are suffering from polluted air, water, and food, have joined activists, NGOs, and intellectuals – pioneers in the environmental movement – to protest against environment-polluting projects or companies in many regions of China (see for example Tang, 2012).

Both top-down and bottom-up forces have made environmental protection an issue of increasing salience in China, which can hardly be ignored by business firms. However, it is undoubted that compared to the developed countries, China's environmental legal system is still far from complete, and the levels of citizens' environmental consciousness still vary extensively across regions and social groups.

(http://www.stats.gov.cn/zjtj/ztsj/hjtjzl/2014/201609/t20160913_1399641.html), last visited on August 3, 2021.

This was particularly the case 10 years ago when the data used in this study was collected. In such an operating context, the signals regarding environmental protection received by business firms can be vague with multiple possible interpretations, depending on their capabilities and the local environment, such as industry, geographic region, and relevant stakeholders. Firms' perception and interpretation of their operating environment shape their reaction embodied in their business strategies (Zhou et al., 2018). In the next section, we explore how firms' environmental responsibility, as their reaction to the increasing trend and pressure of environmental protection, affects their innovation strategy.

3.2 Corporate environmental protection and firm innovation decision

We capture firms' environmental responsibility with their spending on environmental protection. It does not include the fines firms have to pay for violating environmental regulations, e.g., exceeding the limits of emission or waste. Hence, we believe that it reflects firms' active response to the trend of increasing environmental concerns. This can involve investment in restructuring organization to deal with environment-related issues (e.g., build a new department, hire specialists, etc.), purchasing new equipment that reduces environmental impacts in production processes, or sourcing raw materials from greener sources (which often incurs higher costs) that meet environmentally enthusiastic customers' needs and expectations. These activities suggest that such organizations embrace the call for environmental protection, take environmental protection as one of their responsibilities, and tend to interpret the tightened environmental regulations as opportunities rather than crises.

Organizations with a positive interpretation of changes are more likely to have “the dynamic capabilities that can integrate, learn and reconfigure internal and external resources and knowledge” (Zhou et al., 2018, p. 517) to adapt to changing environment, and therefore, are more likely to adopt more proactive strategies such as continuous innovation to respond to increasing environmental concerns (Sharma & Vredenburg, 1998).

The following example of how Starbucks has been constantly redesigning its packaging probably well illustrates this point.⁶ In 1997, Starbucks abandoned the practice of double cupping by introducing a hot cup sleeve. In 2006, it developed the first paper cup with recycled materials. In 2013, Starbucks launched reusable cups and designed a special rewarding program by giving a discount to customers who have purchased and used the reusable cups. Recently, it has partnered with entrepreneurs, industry leaders and leading recyclers to continue to improve its recyclable packaging. This example demonstrates that Starbucks has been proactively investing its human and financial resources in improving its products to reach sustainable development.

The above arguments and example suggest a positive association between firms’ environmental responsibility (captured by environmental protection spending) and innovation strategy (captured by the decision of whether investing in R&D).

Therefore, we hypothesize:

H1: A firm’s environmental protection spending is positively associated with its R&D decision. That is, when a firm is more likely to contribute to environmental protection, it is also more likely to invest in R&D.

⁶ Please refer to Starbuck’s official website:

<https://www.starbucks.com/responsibility/environment/recycling>.

3.3 The mediating effect of government R&D subsidies

Firms do not operate in a vacuum; rather, they are embedded in a complex system (e.g., political, economic, social, technological, environmental, and legal) that constrains their behavior. Government, as one of the most powerful stakeholders, can intervene organizational design and operation by imposing laws, policies, and rules. For example, the Paris Agreement provides a framework for global climate action, guiding countries to develop sustainability. If a country becomes a member of this agreement, it will enforce rules and laws on how its firms should run their businesses, such as reducing their carbon footprint by using environmentally friendly materials to make their products. In 2006, the city of Toronto designed and published the Toronto Green Standard that lists guidelines to promote sustainable building developments⁷. The Standard encourages efficient building design and the use of renewable energy production and recycled materials. When this framework was firstly introduced in 2006, the standard was voluntarily followed as new development. In 2010, the standard was divided into two levels of performance, with Tiers 1 mandatory and Tiers 2 voluntary with financial incentives. As of today, the standard has four tiers, each with a different level of performance. Such climate policy demonstrates expectations and pressures from the government and society. Therefore, we expect that government, as one of the most powerful stakeholders, can shape organizational behaviors through means like imposing laws and regulations as well as proving

⁷ Refer to the website of the city of Toronto (<https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/>), last visit on Aug 10, 2021.

financial subsidies and incentives.

Such government influence on firms is more profound in the contexts in which free-market is underdeveloped and the government has centralized power and authority. In China, the government has control over critical resources such as land, financial loans, and subsidies. These resources are more limited for firms in the private sector, mostly small and medium-sized enterprises, than those large state-owned firms. Therefore, obtaining government support is more critical for private firms in China to survive and thrive. Research in the Chinese context has shown that firms tend to develop political capitals by forming connections with local governments in exchange for critical resources. We wonder whether firms can obtain government support through other measures. Given that the environmental concern has become an increasingly important performance indicator for local governments, we expect that firms that contribute to protecting the environment will have a better relationship with local governments, through which they can acquire critical resources to support their innovation activities.

3.3.1 Corporate environmental protection and government R&D subsidies

When firms perceive the societal expectations for sustainability, they are likely to adjust their behaviors accordingly to respond to the calls for environmental protection. For example, they may spend financial resources on environmental protection activities, such as reducing toxic wastes and emissions. Firms that are proactively doing so can differentiate themselves from competitors by sending out signals to important stakeholders, such as customers and local governments, that they have the

goodwill to produce socially and environmentally responsible products. These signals can resonate with those stakeholders who share similar values, and in turn, are willing to support firms in various ways. For example, customers who prefer green products might be more willing to purchase the products and services offered by environmentally responsible firms, even with a price premium. Local governments might reward such firms by providing financial incentives or technological support to help them to grow further. This would also make them look better in front of the government at the higher level (e.g., provincial or national levels).

In sum, we expect that, when a firm demonstrates its devotion to environmental protection, it is more likely to gain governmental support and reward. Specifically, we hypothesize that:

H2: A firm's environmental protection spending is positively associated with government R&D subsidies. That is, when a firm invests more in environmental protection, it is more likely to receive government R&D subsidies.

3.3.2 Government R&D subsidies and firm innovation decision

R&D activities are usually very costly and risky, which requires a great amount of financial and human resources. In China, firms in the private sector have very limited resources. Compared to state-owned companies, they are facing much more stringent regulations and restrictions, and have more difficulties acquiring financial resources such as loans from banks, which are state-owned. For private firms to conduct R&D activities, government R&D subsidies can be critical resources that can help to alleviate the resource shortage and to boost their confidence in taking the risk. Therefore, whether a private firm can get access to government R&D subsidies should

be highly associated with the firm's R&D decision. The more R&D support a firm receives, the more likely it will invest in R&D. Therefore, we hypothesize that:

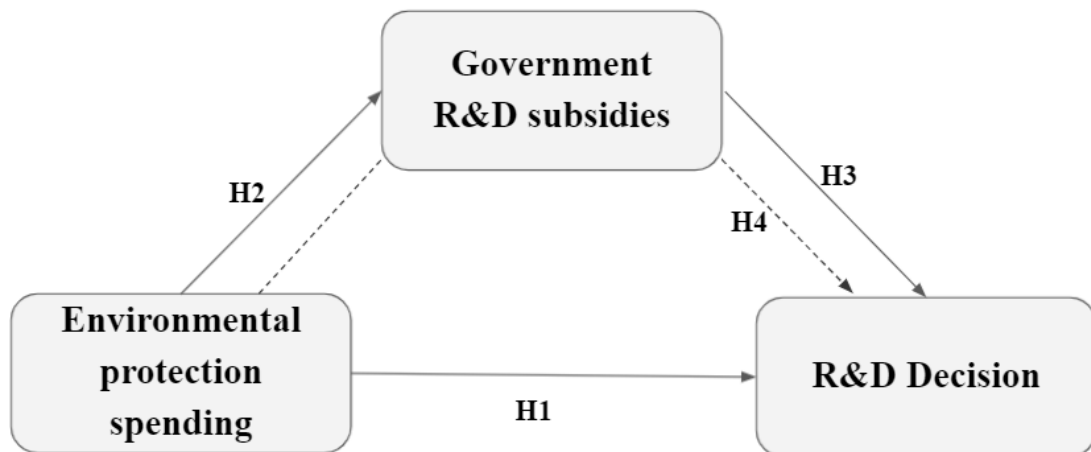
H3: Government R&D subsidies is positively associated with a firm's R&D decision. That is, when a firm receives government R&D subsidies, it is more likely to invest in R&D.

We expect that firms which incorporate environmental strategies and demonstrate their concerns for environment protection are more likely to gain support from the government and get access to critical resources controlled by the government, such as R&D subsidies (H2). We also expect that government R&D subsidies can alleviate the resource shortage problem faced by private firms (H3). Combing H2 and H3, we expect that obtaining government R&D subsidies mediates the relationship between corporate environmental protection spending and firm's R&D decision. Therefore, our last hypothesis is:

H4: Government R&D subsidies mediates the relationship between a firm's environmental protection spending and its R&D decision.

Figure 1 shows the theoretical framework with four hypotheses.

Figure 1: Hypothesized model



Note: The dotted line represents the mediation relationship.

4. METHODS

4.1 Data

We test our hypotheses using Chinese Private Enterprise Survey data. The survey was designed and conducted by the Privately Owned Enterprises Research Project Team, which consists of the United Front Work Department of the Central Committee of the Chinese Communist Party, the All-China Federation of Industry & Commerce, the State Administration for Industry & Commerce of the People's Republic of China, and the China Private Economy Association. The data used in this study were collected during the period from April to June 2010 using the multi-stage cluster sampling method. The sample includes private firms that had been legally founded by the end of 2008 across all 31 provincial-level regions (i.e., 22 provinces, 5 autonomous administrative regions, and 4 centrally-administered municipalities) in China.

4.2 Variables

4.2.1 Dependent variable

The dependent variable for H1, H3 and H4 is *R&D decision*, which is a dummy variable, indicating whether a firm has invested in R&D in 2009, with “yes” coded as 1, and “no” as 0. To test H2, our dependent variable is *government R&D subsidies*, which is a dummy variable with a value of 1 indicating that a firm has access to the local governments' financial resources to support R&D, and 0 otherwise.

4.2.2 Independent variables

The independent variable for H1, H2, and H4 testing is *corporate environmental protection spending*, a dummy variable indicating whether a firm has spent its financial resources in environmental protection in 2009. To test H3, we use

government R&D subsidies, as the independent variable.

4.2.3 Control variables

We control for variables at the firm-level, firm owner-level, industry-level, and regional-level that might have effects on a firm's R&D decision and government R&D subsidies. At the firm-level, we control for *Firm age*, a continuous variable indicating the number of years since a firm was founded until 2010. Firm age can affect a firm's R&D decision because more established firms tend to have accumulated more resources over time that allow them to invest in risky activities such as R&D. We also control for firm's *Financial performance*, a continuous variable measured by the firm's total revenue in 2009. Since it is positively skewed, we use its logarithm forms in the statistical analyses to reduce potential estimate biases. Moreover, we control for *Access to loan*, a dummy variable with the value of 1 indicating that the firm has bank loans in 2009, and 0 otherwise. We include this variable in our analysis because research that used the same dataset has shown that compared with firms that have no access to loans, those that obtained loans are more likely to invest in R&D activities (Cumming et al., 2016). In addition, we control for firm's ownership history. We include a dummy variable, *State*, which indicates that whether a firm was privatized from a state-owned enterprise, "yes" is coded as 1 and 0 otherwise. We expect that prior state-owned firms might get access to governmental resources more easily than others due to their political connections.

At the owner-level, we first include *Owner Age* in the year of 2010 in our analysis and *Gender*, a dummy variable with the value of 1 representing male and 0 female.

Next, we control for the owner's educational level and include a dummy variable *College* to indicate whether the owner has received a college degree or a higher degree. Following the common practice in management literature conducted in China, we also add *Political Connection* to control for owner's political capital because it can be a critical resource for firm owners in a transition economy with an under-developed free market. For example, Cumming et al (2016) have found that private firms with owners having a People's Congress membership (PC) or a Chinese people's Political Consultative Conference (CPPCC) membership are more likely to obtain innovation funds from local governments, which in turn can positively influence their innovation activities. Thus, we include a dummy variable indicating whether a firm's owner is a member of PC or CPPCC.

Furthermore, we control for *Industry* effects, because the level of innovation activities and performance varies across industries. Following the coding practice of studies using the same data (Luo et al., 2019) and the China Industry Classification System, we code *Industry* into three main categories: agriculture, manufacturing, and service, and enter two dichotomous variables to indicate agriculture and manufacturing industries in the statistical models, with service industries as the reference group. Finally, we add *Location* in our analysis to control for the effect of a firm's geographical location. China's transition economy has not been developing equally across different regions, and this broad context can potentially affect firms' strategic decisions. It is a categorical variable with the value of 1 indicating the East and South Provinces, 2 the West provinces, and 3 the rest (i.e., the inner land). We

entered two dummy variables to indicate whether a firm is located in a west province or an inner land province; those located in an east and south province are the reference group.

After data cleaning, the final sample includes 1,998 observations. The descriptive statistics of all variables are presented in Table 1, and the correlation matrix is presented in Table 2.

4.3 Models

We use Logit models to test H1, H2, and H3 because our dependent variables are dichotomous. To test the mediation effect of government R&D subsidies (H4), we apply the KHB method developed by Karlson, Holm, and Breen (2013).

Table 1: Variable Definitions and Descriptive Statistics

Variable	Definitions	Mean	Std. Dev.	Min	Max
R&D decision	whether a firm has invested in R&D in 2009 (0/1)	.373	.484	0	1
Government R&D subsidies	whether a firm has received government R&D subsidies in 2009 (0/1)	.139	.346	0	1
Environmental protection	whether a firm has spent its financial resources on environmental protection in 2009 (0/1)	.333	.472	0	1
Firm age	the number of years of firm establishment until 2009	8.648	4.622	0	21
Financial performance	the natural log of total revenue in 2009	6.487	2.425	0	13.361
Access to loan	whether the firm has bank loans in 2009 (0/1)	.505	.5	0	1
State	whether a firm was privatized from a state-owned enterprise (0/1)	.154	.361	0	1
Gender	a dummy variable with 1 representing male and 0 representing female	.864	.342	0	1
Owner age	the firm owner's age in 2009	45.699	8.59	19	90
College	whether a firm owner has a college degree (0/1)	.623	.485	0	1
Political connection	whether a firm's owner is a member of PC or CPPCC (0/1)	.434	.496	0	1
Agriculture	whether a firm belongs to the agriculture sector (0/1)	.079	.269	0	1
Manufacturing	whether a firm belongs to the manufacturing sector (0/1)	.502	.5	0	1
Service	whether a firm belongs to the service sector (0/1)	.419	.494	0	1
South and East	whether a firm locates in the South or East area (0/1)	.566	.496	0	1
West	whether a firm locates in the West area (0/1)	.183	.387	0	1
Inner land	whether a firm locates in the Inner land area (0/1)	.251	.434	0	1

Table 2: Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) R&D decision																
(2) Government R&D subsidies	0.394															
(3) Environmental protection	0.343	0.312														
(4) Firm age	0.181	0.088	0.139													
(5) Financial performance	0.378	0.320	0.315	0.277												
(6) Access to loan	0.268	0.241	0.248	0.195	0.419											
(7) State	0.109	0.138	0.122	0.000	0.206	0.132										
(8) Gender	0.082	0.070	0.100	0.062	0.144	0.107	0.056									
(9) Owner age	0.088	0.071	0.083	0.234	0.230	0.122	0.172	0.105								
(10) College	0.101	0.097	0.020	-0.012	0.130	0.015	0.041	0.017	-0.153							
(11) Political connection	0.209	0.216	0.182	0.286	0.370	0.272	0.127	0.126	0.162	0.094						
(12) Agriculture	0.113	0.130	0.113	0.024	0.051	0.111	-0.032	0.045	0.013	-0.030	0.127					
(13) Manufacturing	0.276	0.148	0.224	0.127	0.304	0.216	0.170	0.117	0.224	-0.065	0.092	-0.293				
(14) Service	-0.342	-0.221	-0.289	-0.142	-0.336	-0.279	-0.155	-0.143	-0.234	0.082	-0.163	-0.248	-0.853			
(15) South and East	0.096	0.051	0.061	0.078	0.105	0.048	0.005	0.036	-0.004	-0.022	-0.056	-0.044	0.096	-0.074		
(16) West	-0.087	-0.025	-0.003	0.004	-0.042	0.035	-0.002	-0.016	0.030	0.040	0.066	0.068	-0.092	0.056	-0.540	
(17) Inner land	-0.032	-0.035	-0.067	-0.092	-0.083	-0.086	-0.004	-0.027	-0.022	-0.011	0.005	-0.010	-0.028	0.034	-0.661	-0.274

5. RESULTS

Table 3 presents the results of logit models for hypotheses testing. Model 1 shows that environmental protection spending has a significant positive association with firm R&D decision (coef. = 0.935, $p < 0.01$). It means that the odds of investing in R&D for firms that do spend their financial resources on environmental protection are 2.55 times higher than those that do not. Hypothesis 1 is supported. Model 2 examines the relationship between environmental protection spending and government R&D subsidies. The result shows that environmental protection spending is significantly and positively related to government R&D subsidies (coef. = 1.150, $p < 0.01$). This means that compared with firms that do not have environmental protection spending, the odds of obtaining government R&D subsidies for those that do is 2.16 times greater; this provides supporting evidence for Hypothesis 2. Model 3 shows that government R&D subsidies has a positive relationship with firm R&D decision (coef. = 1.911, $p < 0.01$). It means firms that receive R&D support from the government are more likely to invest in R&D activities; the odds is 6.76 times of that of firms not receiving any support. This result supports Hypothesis 3.

Table 3: Logit Model Results

Dependent Variable	Model 1 R&D decision	Model 2 Govt. R&D subsidies	Model 3 R&D decision	Model 4 R&D decision
Environmental protection spending	0.935*** (0.114)	1.150*** (0.156)		0.766*** (0.119)
Government R&D subsidies			1.911*** (0.190)	1.755*** (0.193)
Firm age	0.037*** (0.013)	-0.017 (0.0182)	0.047*** (0.0128)	0.043*** (0.0130)
Financial performance	0.229*** (0.030)	0.304*** (0.045)	0.216*** (0.0304)	0.194*** (0.031)
Access to loan	0.351*** (0.117)	0.668*** (0.179)	0.314*** (0.119)	0.272** (0.121)
State	0.007 (0.150)	0.289 (0.179)	-0.036 (0.154)	-0.067 (0.157)
Gender	-0.068 (0.169)	0.028 (0.267)	-0.009 (0.171)	-0.061 (0.172)
Owner age	-0.008 (0.007)	-0.003 (0.010)	-0.010 (0.007)	-0.009 (0.007)
College	0.429*** (0.118)	0.386** (0.170)	0.352*** (0.119)	0.379*** (0.121)
Political connection	0.205* (0.118)	0.602*** (0.164)	0.122 (0.120)	0.108 (0.122)
Agriculture	1.326*** (0.209)	1.290*** (0.269)	1.284*** (0.214)	1.128*** (0.217)
Manufacturing	1.037*** (0.126)	0.631*** (0.202)	1.117*** (0.127)	1.016*** (0.130)
West provinces	-0.638*** (0.154)	-0.396* (0.209)	-0.606*** (0.159)	-0.618*** (0.160)
Inner land provinces	-0.035 (0.132)	-0.167 (0.187)	-0.040 (0.134)	-0.013 (0.136)
Constant	-3.423*** (0.374)	-5.898*** (0.576)	-3.218*** (0.377)	-3.229*** (0.380)
Observations	1,998	1,998	1,998	1,998

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Lastly, Model 4 presents the results of the full model. Both environmental protection spending and government R&D subsidies are positively related to firm R&D decision. The coefficient of environmental protection spending is 0.766 ($p < 0.01$), which seems to be smaller than 0.935 in Model 1. This may suggest its reduced effect on R&D decision due to the mediated effect of government R&D subsidies. We further test the mediation effect using the KHB method and report the results in Table 4. It shows that expenditure of environmental protection increases the log odds of investing in R&D by 1.023. After the mediator, government R&D subsidies, is introduced, the effect of environmental protection spending on R&D decision is reduced to 0.766, which indicates its direct effect, resulting in an indirect effect of 0.257 through government R&D subsidies. These results mean that the total effect of environmental protection spending is 1.335 ($1.023/0.766$) times of its direct effects, and 25.1% ($0.257/1.023$) of the total effect is due to the effect of government R&D subsidies. Both the direct and indirect effects of environmental protection spending are significant, it means that government R&D subsidies only partially mediates the effect of environmental protection support on R&D decision. Hypothesis 4 is therefore supported.

Table 4: Decomposition of the Effects of Environmental Protection Spending on R&D Decision.

	Coefficient	P>z
Total effect	1.023	0.000
Direct effect	0.766	0.000
Indirect effect	0.257	0.000

6. DISCUSSION

6.1 Findings and implications

We have found positive relationships among corporate environmental spending, government R&D subsidies, and firm R&D decision. Our study has a few implications. First, the positive relationship between corporate environment spending and R&D decision suggests that CER may enhance firm innovation. By incorporating a concern for the natural environment, a firm is more likely to invest in R&D to improve its product and process, including but not limiting to making its business greener to actively respond to the societal call for sustainable development. Second, our finding of the positive relationship between CER and government R&D subsidies implies that a firm's environmental contribution can create corporate goodwill and reputation, which helps the firm to get access to stakeholder recognition and support. More specifically, in the private sector of China, local governments might be more willing to financially support firms with CER to engage in R&D activities. Third, our finding that government R&D subsidies is positively associated with firm R&D decision suggests that financial support from powerful stakeholders such as local governments is critical for firm's innovation decisions and activities. R&D is highly risky and uncertain, and obtaining more resources can provide firms with more confidence and can motivate them to take the risks inherent in R&D activities. Lastly, we have found that government R&D subsidies partially mediates the positive relationship between CER and firm R&D decision. This means that Chinese private firms' investment in environmental protection might boost their intention to engage in R&D activities in two ways – by enhancing internal motivation and by obtaining external support. Firms that proactively incorporate environmental concerns in their strategies in a context where environmental laws are still being developed and public

awareness of environmental issues are emerging are likely to have stronger capabilities to cope with changes and uncertainties in their external operating environment by perceiving them as opportunities rather than threats. To respond to the changes and uncertainties in the external environment, those firms are more likely to engage in R&D activities to update their production processes and products and keep themselves adaptive. Moreover, contributing to environmental protection helps firms obtain local governments' recognition and financial support, which essentially expands the pool of organizational resources. Government support and subsidies relieve resource constraints that firms suffer to engage in multiple and potentially competing activities and serve as a buttress against the risks inherent in R&D activities.

Apart from the hypothesized effects, some effects of our control variables are noteworthy. Consistent with prior research, we find that firm age is positively related to innovation intention (Sørensen & Stuart, 2000). This may be due to firms' accumulated resources and capabilities over time that can support them to conduct risky R&D. However, firm age has no effect on obtaining government support. This suggests that political capital in China cannot automatically be obtained as firms survive and age in a region; it might require owners' intentional proactivity to build connections with the local governments. Firm performance and access to loans are positively related to firms' R&D decision and government support. These results make sense because both of them can expand firms' resources to conduct R&D and can also be enhanced by firms' R&D decision. They are also positively associated with government R&D support. This suggests that local governments tend to support firms with better performance in their jurisdictions and provide them with various resources, which in turn enhance their performance, forming a positive feedback loop.

Furthermore, owners' education is positively related to R&D decision and government support. This finding suggests that owners' university education can equip them with more knowledge, stronger learning capabilities, and sharper insights that help their firms' gain external resources and facilitate R&D activities. Finally, the effect of political connection is interesting. It has a positive effect on R&D decision; however, after including government R&D subsidies into the regression, its positive relationship with R&D decision disappears. This may suggest that political connection is spuriously related to firms' R&D decision. In other words, political connections do not facilitate firms to invest in R&D and vice versa, but rather, the observed relationship between the two is due to their positive associations with government subsidies. If firms do not take advantage of their political connections and transform them into substantial resources gained from local governments, such political capital will not affect their firms' innovation strategies or R&D activities.

6.2 Practical implications

This study can have practical implications for firm owners and managers. Our findings suggest that it is important for them to know that being environmentally friendly and investing in environmental protection may not necessarily be with the sacrifice of innovation activities. Although the increasing environmental concerns can impose pressures and constraints on firms, it also provides rich opportunities for firms to learn and innovate. What matters probably is firms' dynamic capabilities that help them to mobilize and reconfigure their competence and resources to respond to changing environment (Teece et al., 1997). With strong dynamic capabilities, firms can approach environmental protection from a positive perspective and incorporate it in firms' innovation strategies. Therefore, business owners and managers should develop their firms' dynamic capabilities.

Moreover, it should also be recognized that investing in environmental protection can bring in external resources from key stakeholders, such as local governments, to support firms' innovation activities. This is especially important for private firms with limited financial and political resources in China. Due to the increasing pressure from the central government and the widening awareness of environmental protection, local governments have increasing incentives to protect the environment in their jurisdictions, and therefore are more motivated to cultivate good relationships with the local businesses that actively incorporate environmental protection in their strategies by providing them with critical resources. Hence, owners of private firms can build and strengthen political connections by investing in environmental protection and gain more resources through those connections.

6.3 Limitations and future research

Our study is not without limitations. First, the data used in this study is cross-sectional survey data. Therefore, we must interpret our findings cautiously and draw implications from the results carefully. Although we theorize the effect of CER on firm innovation strategy by arguing that spending on environmental protection increases the probability that firms are engaged in R&D activities, we cannot establish the causality between the two. The arguments that support the reverse causality are conceivable. We encourage future research to further investigate the causal relationship between the two using longitudinal data. However, we have stronger confidence in our theory of the mediation effect of government support from the perspective of stakeholder theory. It would not make much sense to argue that firms are more likely to spend on environmental protection after obtaining R&D subsidies from local governments.

Second, we only use environmental protection spending to measure CER, which

can be multi-dimensional. A firm must be consistently sustainable in all aspects of its business operations, including green sourcing, green management, green supply chain, etc., to be called environmentally friendly. We hope future research can use multifaceted measures to further explore the relationship between CER and firm innovation decision.

Third, we examine the mediating effect of only one key stakeholder of firms – local governmental – in the relationship between environmental protection spending and R&D decision and find a partial mediation effect. However, we know that firm strategies and performance are affected by multiple external and internal stakeholders, which can also interact with one another among themselves. Future research can deepen our understanding by examining the combined effects of multiple stakeholders in the relationship between CER and firm innovation decision.

Finally, our empirical context is the private sector in China. Due to the political regime and relatively low level of marketization, local governments play a vital role in private firms' business and operation. Whether our findings hold in other contexts is still an open question. We hope future researchers can test the same relationships in different contexts.

7. CONCLUSION

Our research question is: Are environmentally friendly firms more innovation-oriented, especially among smaller firms with limited resources? We answer this question by using the data of 1,998 Chinese private firms collected in 2010. We find that firms that spend their financial resources on environmental protection are more likely to invest in R&D activities. This positive relationship may be due to organizational capabilities of perceiving the increasing awareness of environmental issues in the society as opportunities instead of threats for the established business

processes. Furthermore, we also find that access to R&D subsidies from local governments plays a crucial role in this relationship. It means that attending to environmental issues helps firms to gain government recognition and support, which expand their resources thus encouraging them to engage in risky innovation activities.

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