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**Environmental regulations and green supply chain
management: The role of entrepreneurship and resource
commitment**

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Environmental regulations and green supply chain management: The role of entrepreneurship and resource commitment

Abstract

The micro-foundation of how environmental regulations will affect firms' adoption of green supply chain management (GSCM) practices remains unclear in the literature. This study examines whether entrepreneurship and resource commitment will mediate the relationship between environmental regulation intensity and the adoption of GSCM practices. Based on a sample of 231 manufacturers, this paper demonstrates that environmental regulation intensity has no direct effect on GSCM practices but has indirect effect on GSCM practices through the entrepreneurship and resource commitment of firms. Drawing on institutional theory, our study contributes to a better understanding of the effect of environmental regulations on firms' GSCM by unpeeling the micro-foundations of firm-specific factors in terms of entrepreneurship and resource commitment.

Keywords: Environmental regulations, entrepreneurship, resource commitment, green supply chain management

Track: Operations, Logistics and Supply Chain Management

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1. Introduction

Faced with increasingly serious environmental issues, governments around the world have established a series of environmental regulations to drive firms to adopt environmental-friendly initiatives. Green supply chain management (GSCM) practices have been identified as important strategic initiatives to reduce environmental risks and increase ecological efficiency (Zhu et al., 2007). However, despite the introduction of various environmental regulations, many firms are still at a preliminary stage of adopting GSCM practices (Bello-Pintado et al., 2023; Liu et al., 2012; Long et al., 2023). For the last decade, to determine ways to promote GSCM, institutional theory was used to explain the implementation of environmental related practices in supply chain management (Sarkis et al., 2011; Kauppi, 2013). However, the impact of environmental regulation on the adoption of GSCM practices is still not conclusive from previous studies. Some research argued that regulatory pressure positively influences the adoption of GSCM practices (e.g., Liu et al., 2012; Wu et al., 2012), while other research suggested that legal requirements are not valid motivators for the adoption of GSCM strategic orientation (Bello-Pintado et al., 2023; Liu et al., 2020). Owing to these contradictory findings, further research is needed to explicate the relationship between environmental regulation intensity and the adoption of GSCM practices by contemporary firms.

As a kind of institutional pressure, environmental regulations cause isomorphism among organizations. Even under the same level of environmental regulation, some firms adopt GSCM practices beyond regulatory compliance, while other firms lag behind regulation requirements (Zhu et al., 2012; Zhao and He, 2022). Hence, regulations alone may not be sufficient to explain the varied environmental behaviors of firms (Cassell and Lewis, 2011, Zhao and He, 2022), and, in particular, the environmental operations of supply chains (Zhang and Dhaliwal, 2009). The heterogeneous adoption of environmental management practices may be attributed to different interpretations of institutional pressures by firms due to firm-specific organizational characteristics (Delmas and Toffel, 2004). Therefore, to open the black box of efficacy of environmental regulation intensity on GSCM adoption, further exploration of the micro-foundation of GSCM adoption is necessary.

Recent research has been interested in the important role entrepreneurship has played in innovation and sustainable development (e.g., Chavez et al., 2020; Hsu et al., 2014). Entrepreneurship is understood to be a process of strategic renewal to the environment (Lumpkin and Dess, 1996) and is characterized by innovativeness, proactiveness, and risk taking (Miller, 1983). Previous research found that a firm with strategic orientation towards entrepreneurship is associated with advanced operational core competency, innovation (Hsu et al., 2014) and manufacturing system and sustainability performance (Chavez et al., 2020). Entrepreneurship has become a firm's core ability to perform successfully in increasingly competitive environments (Simsek et al., 2010). What makes a firm entrepreneurial, however, is a question which remains to be answered (Eshima and Anderson, 2017). Meanwhile, there were limited studies examining the role of entrepreneurship to explicate the micro-foundations of firms' adoption of GSCM practices. Thus, based on the

proposition that intensive institutional environmental pressure will unlock entrepreneurship (Bruton et al., 2010), this study attempts to examine the influence of environmental regulations on firms' entrepreneurship and the subsequent impact of entrepreneurship on the adoption of GSCM practices.

Since resources availability and the capacities of resources deployment are necessary for GSCM adoption (Roehrich et al., 2014), innovative application and a combination of existing resources contribute to the outcome of strategies (Christmann, 2000). Questions remain to be answered on how resources can be configured more effectively to facilitate GSCM practices, and whether environmental regulations would affect the allocation of resources by firms. Hence, this study also includes the resource commitment of firms as a mediator of the relationship between environmental regulation intensity and GSCM practices. Therefore, this study aims to examine the links between environmental regulation intensity and two important organizational characteristics (i.e., entrepreneurship and resource commitment), to explain the adoption of GSCM practices by firms. This study contributes to available literature by providing a better understanding of the mechanisms through which environmental regulations drive GSCM practices. Considering the general lack of studies on GSCM from the perspective of entrepreneurial orientation, this study unpeels some important micro-foundations of firms' adoption of GSCM practices by clarifying the important role of entrepreneurship and the role of resource commitment in the relationship between environmental regulation intensity and GSCM adoption.

2. Literature review

2.1 Institutional theory and environmental regulations

This study draws on institutional theory which has been applied in supply chain management research for the past decade (e.g., Cai et al., 2010; Liu et al., 2010; Zhu et al., 2013b). According to institutional theory, organizations implement business practices to enhance their legitimacy by conforming to three institutional isomorphic pressures, namely normative, mimetic, and coercive pressures (DiMaggio and Powell, 1983). Normative pressures cause organizations to conform to social legitimacy concerns in organizational practices. This pressure stems from professionalization, the "collective struggle of members of an occupation to define the conditions and methods of their work, to control the production of producers" (DiMaggio and Powell, 1983). Mimetic pressures come from imitation which occurs when one or more organizations' adoption of some practice increases the likelihood of that practice being adopted by other organizations (DiMaggio and Powell, 1983). Coercive pressures stem from the pressures exerted on organizations by other organizations upon which they are dependent, and by cultural expectations in the society within which organizations function (DiMaggio and Powell, 1983).

In this study we focus on the role of regulatory authorities, which are typical examples of powerful groups that may exert coercive pressures and influence the strategic responses and actions of organizations (Zhao and He, 2022; Zhu et al.,

2013b). As a specific type of coercive pressure imposed by regulatory authorities (Delmas and Toffel, 2004; Zhu et al., 2013b), environmental regulations are related to the extent to which the regulations create threat or actually impede an organization's operations based on their environmental performance (Delmas and Toffel, 2004). The use of adequate environmental regulations has been recognized as an important instrument in facilitating firms' pro-environmental operations such as GSCM practices (Zhao and He, 2022; Zhu et al., 2013b).

With increasing attention on environmental sustainability, governments around the world have established many environmental regulations locally and internationally, which have resulted in greater institutional pressures for improved environmental management by firms (Asif et al., 2020; Zhu et al., 2013b). However, the influence of environmental regulation pressures on the adoption of GSCM practices is still inconclusive, with contradictory findings in previous studies (Bello-Pintado et al., 2023; Liu et al., 2012; Liu et al., 2020; Tachizawa et al., 2015; Wu et al., 2012). For example, Liu et al. (2012) and Wu et al. (2012) found that regulatory pressure significantly and positively influences the adoption of GSCM practices, while, on the other hand, Bello-Pintado et al. (2023) and Liu et al. (2020) found that regulations do not exhibit a statistically significant effect on supply chain sustainability practices. Differing from the above views, Tachizawa et al. (2015) observed that environmental regulations have a positive effect on monitoring GSCM practices, but have a negative effect on collaboration GSCM practices. Thus, further research is needed to establish the relationship between environmental regulation intensity and the adoption of GSCM practices by firms.

A review of extant literature suggests that what is currently missing in the field is the lack of clear understanding of the mechanisms which explain the relationship between environmental regulation intensity and GSCM practices. The current literature is somehow indecisive in determining the mechanisms through which environmental regulations will convert into pro-environmental actions, with only a few exceptions (e.g., Delmas and Toffel, 2004; Liu et al., 2012; Zhao and He, 2022).

In this paper we focus on the entrepreneurship and resource commitment of firms and argue that these two factors form important micro-foundations which will mediate the relationship between environmental regulation intensity and the adoption of GSCM practices by firms. As an environmentally sustainable innovation (Zhu et al., 2012), GSCM would require corporate entrepreneurship and resource commitment within firms (Beske and Seuring, 2014; Hsu et al., 2014; Srivastava, 2007). Entrepreneurship is a key enabler of innovation (Hsu et al., 2014) and plays an increasingly important role in promoting sustainable development (Chavez et al., 2020; Sharma et al., 1999). Resource commitment is the basic premise of innovation capacity (Noble et al., 2002) and can serve as a necessary factor in converting external pressures into pro-environmental action (Liu et al., 2020).

2.2 Entrepreneurship

Entrepreneurship refers to a process of opportunity recognition and pursuit for value creation in complex and risky markets (Hsu et al., 2014). It is normally attributed to

the introduction of revolutionary inventions. The success of small businesses contributes to economic growth and new-job creation (Lumpkin and Dess, 1996). Traditionally, entrepreneurship has been understood to be a characteristic of an innovative, risk-taking individual attempting to achieve commercial success, especially in the start-up of new firms (Morris and Paul, 1987). However, entrepreneurship has been increasingly accepted to be a process or activity within an organization (Brown et al., 2001) that is relevant to organizations of any size (Miller and Friesen 1982, 1983), rather than just to individual entrepreneurs. In this vein, entrepreneurship is considered to be a process of strategic renewal at firm-level (Lumpkin and Dess, 1996; Morris and Paul, 1987).

Miller (1983) identified a pattern of strategic actions of entrepreneurially oriented firms encompassing three dimensions: innovativeness (introduction of new products, processes, and business models), proactiveness (actively entering new product/market spaces and seeking market leadership positions), and risk-taking (willingness among strategic decision makers to contribute resources to projects with uncertain outcomes) (Anderson et al., 2015). In this vein, Morris and Paul (1987) defined entrepreneurial orientation as the propensity for a company to be innovative, to demonstrate proactiveness, and to take calculated risks in their approach to strategic decision making in the pursuit of new opportunities.

There has been increasing interest in studying the relationship between entrepreneurship, innovation, and sustainable development. For instance, Hsu et al. (2014) found that corporate entrepreneurship positively affects firms' operational core competency and subsequent innovation. Chavez et al. (2020) empirically showed that entrepreneurial orientation may improve firms' sustainable development through leveraging internal lean practices. On the basis of previous empirical evidence, it is expected that there are also links between entrepreneurship and GSCM, which is considered to be a type of environmentally sustainable innovation (Zhu et al., 2012). However, the role of entrepreneurship in the firms' engagement with GSCM practices is still underexplored. In this study, we argue that entrepreneurship lies at the core of explaining the micro-foundation of firms' GSCM practices. Therefore, we will examine the role of entrepreneurship in converting environmental regulations into GSCM practices.

2.3 Resource commitment

GSCM practices involve both internal and external connections between operations and organizations, which are often multidimensional, dynamic and complex (Rauer and Kaufmann, 2015; Vachon and Klassen, 2006). Effective implementation of GSCM is likely to affect the whole system of supply chain operations of firms (Zhu et al., 2012). To effectively implement GSCM, firms need to commit their resources precisely in a targeted way.

In this regard, a more targeted resource utilization pattern is needed to facilitate the fundamental operations of GSCM (Liu and Chang, 2017). GSCM approaches, such as "cradle to cradle" (i.e., recirculation of materials from a holistic lifecycle

view), closed-loop supply chain, and eco-design, imply resource commitment of firms in a more systematic way throughout the whole supply chain process and the product lifecycle (Liu et al., 2020; Schmidt et al., 2021). Following this thread, in this study, resource commitment refers to a circular oriented allocation and utilization of firm resources through a holistic lifecycle view on materials and products from early product development to the production, consumption, and closed-loop recirculation of products and materials based on the scope of the entire supply chain. For instance, with a GSCM oriented resource commitment, firms may invest in activities that they would not normally do, such as adopting new technologies for processing used materials, establishing environmental management systems for the recirculation of materials, and developing employee training programs for recycling.

3. Hypothesis development

3.1 Environmental regulations and GSCM

Firms may lack the external motivation to initiate environmental management practices when they are exposed to limited pressures (Zhu et al., 2012). Institutional theory posits that firms' business practices are influenced by institutional isomorphic pressures, which could be coercive, normative, or mimetic pressures (DiMaggio and Powell, 1983). Government and regulatory authorities can exert coercive pressures on firms to influence firms' environmental management behaviors in complying with environmental laws and regulations (He et al., 2019).

In previous studies, evidence was gained on the positive relationship between environmental regulations and firms' environmental management behaviors, such as ISO 14001 (Delmas, 2002), environmental innovation (Berrone et al., 2013), general environmental management system (Zhu et al., 2013a), and GSCM adoption (Giunipero et al., 2012; Wu et al., 2012; Zhu et al., 2013b). Environmental regulations, being an important example of institutional pressures, will affect how likely firms will be to adopt GSCM practices. Hence,

H1. Environmental regulation intensity is positively related to the adoption of GSCM practices by firms.

3.1.2 Environmental regulations and entrepreneurship

The level of entrepreneurship is directly related to the regulations which shape the institutional context (Baumol et al., 2009). Specifically, the innovativeness towards entrepreneurial decisions could be affected by the institutional environment of the firms which are involved (Bruton et al., 2010). As an indispensable institutional force, regulations can provide guidelines for entrepreneurially oriented firms to improve the legitimacy of the firms (Bruton et al., 2010). In addition, effective regulations can

facilitate entrepreneurship (Aparicio et al., 2016; Lim et al., 2010) by reducing transaction costs (North, 1990), protecting property rights and ensuring fair competition (Broadman et al., 2004; Ahlstrom et al., 2000). Properly designed environmental regulations can encourage innovation such as new products, new technologies or new approaches to production, to offset the costs of complying with these regulations, and subsequently achieve early-mover advantage (Porter, 1991; Porter and Linde, 1995). In that sense, we argue that environmental regulations can promote entrepreneurship. Hence,

H2. Environmental regulation intensity is positively related to the level of entrepreneurship of firms.

3.1.3 Environmental regulations and resource commitment

Resource selection and deployment decisions are embedded in regulatory environment (Oliver, 1997). Regulatory pressures influence the use of resources by prescribing uniform resource standards and ways of deploying resources across given industries (Oliver, 1997). Environmental regulatory requirements would force firms to adjust their business models and dedicate their resources to more comprehensive environmental practices for business success (Sharma et al., 1999).

On the other hand, it is widely understood that under no environmental institutional pressures, firms would not allocate their resources to environmental practices (Wu et al., 2012). Lack of mandates may impede incorporation of circular principles into firms' business strategies, obviating the need to plan for waste reduction as well as material and product recycling and recovery (Veleva and Bodkin, 2018). In addition, closed-loop oriented environmental management, such as recycling and waste management, is often described as cost-reducing and an easy-to-do practice (Cassells and Lewis, 2011; Tilley, 1999). Thus, the increasingly strict environmental regulations would result in firms more actively exploring approaches to resource utilization towards the recirculation for cost-savings. Hence,

H3. Environmental regulation intensity is positively related to resource commitment by firms.

3.2 Entrepreneurship and resource commitment

Effective entrepreneurship requires the commitment of resources (Covin and Slevin, 1991; Eshima and Anderson, 2017). The key criterion of entrepreneurship is whether a firm can devote more resources to innovation or not (Schumpeter, 1942). According to Shane (2012), entrepreneurship is concerned with the recombination of existing resources to pursue business opportunities.

To adopt GSCM, necessary new technologies need to be invested in, for example, to effectively transform wastes into reusable resources (Dantas et al., 2021). However, those innovative technologies can be very expensive and require substantial investment without short-term benefits (Sharma and Henriques, 2005). Nevertheless, entrepreneurially oriented firms are more likely to discover, evaluate and exploit

opportunities through the more efficient utilization of resources based on early signals from its environments (Dean and McMullen, 2007; Wiklund and Shepherd, 2003). Moreover, entrepreneurially oriented firms are better positioned to take risks. According to Miller and Friesen (1978), risk-taking is linked with firms' willingness to take large and risky resource commitments. Therefore, it is reasonable to argue that entrepreneurially oriented firms are more ready to commit their resources in GSCM practices. Therefore,

H4. Entrepreneurship of firms is positively related to resource commitment by firms.

In more intensive regulatory environments, entrepreneurially oriented firms may adopt more proactive innovation strategies through adjusting their business models and reallocating their resources (Sharma et al., 1999). Such proactiveness will make firms bearing more risks and creating better value to their processes (Suchek et al., 2022). Hence, entrepreneurship can be a catalyst to converting regulatory pressures into proactive actions of firms. Therefore,

H5. Entrepreneurship of firms mediates the positive relationship between environmental regulation intensity and resource commitment by firms.

3.3 Entrepreneurship and GSCM

Innovation is a specific instrument of entrepreneurship (Drucker, 1985). Schumpeter (1942) proposed "creative destruction" (i.e., innovations and commercialization of innovations) as the defining characteristic of entrepreneurship. The risk-taking embedded in entrepreneurship encourages firms to initiate technological and managerial innovations to respond to external challenges (Miller and Friesen, 1983). Firms with a strategy oriented towards entrepreneurship are more likely to be the first ones to come up with proactive innovations (Hsu et al., 2014; Miller, 1983). In this vein, firms with more entrepreneurial orientation are more likely to take proactive environmental strategies through innovative actions to gain early-mover advantages, rather than reactive strategies directed toward compliance with environmental regulations (Sharma et al., 1999).

Generally, innovativeness is needed by firms to encourage them to take proactive initiatives in pursuing new opportunities in their supply chains (Hsu et al., 2014). Hence, the capacity for proactive innovation has been identified as a precursor to creating more sustainable supply chains (Pagell and Wu, 2009). In essence, GSCM is an environmental management innovation (Zhu et al., 2012), which will be affected by the entrepreneurship of firms (Drucker, 1985).

Adoption of GSCM practices tends to have long term effect and needs substantial investment, often without immediate short-term benefits (Sharma and Henriques, 2005). Risk-aversion to innovation may be detrimental to the adoption of GSCM practices (Zhu et al., 2012). On the other hand, entrepreneurship with risk-taking embedded may play a critical role in promoting firms to engage in green innovation in their supply chains. Therefore,

H6. The entrepreneurship of firms is positively related to the adoption of GSCM

practices by firms.

Regulation imposes coercive pressures on firms (Delmas and Toffel, 2004). However, regulations themselves may be insufficient to address the firms' environmental concerns (Cassell and Lewis, 2011), particularly at the operational level of firms' supply chain management (Zhang and Dhaliwal, 2009). Firms interpret environmental regulation pressures in different strategic ways, which will be associated with different types of environmental practices adopted by individual firms (Sharma and Henriques, 2005). The adoption of environmental management practices is the result of a firm's strategic position (Ardito and Dangelico, 2018). Different strategic positions toward innovation and the attendant risk of the firms may lead to different rates of adopting GSCM practices (Zhu et al., 2012). Therefore,

H7. The entrepreneurship of firms mediates the positive relationship between environmental regulation intensity and the adoption of GSCM practices by firms.

3.4 Resource commitment and GSCM

Sustainability-oriented innovation requires firms to shift away from practices that are not resource-efficient (Ardito and Dangelico, 2018) and identify specific resources and competencies that help firms to pursue systematic changes (Dangelico, 2016). As an important type of environmental innovation (Zhu et al., 2012), GSCM practice transcends individual firm's operations to incorporate multidimensional, complex, and dynamic processes (Rauer and Kaufmann, 2015; Vachon and Klassen, 2006). Its implementation extends to the entire supply chain of firms (Zhu et al., 2012), and normally requires substantial long-term investment (Ardito and Dangelico, 2018). For instance, as one of the important concepts of GSCM, the recirculation of materials for closed-loop supply chains requires the commitment of closed-loop oriented resources such as recycling systems and infrastructures in waste management (Liu and Chang, 2017; Schmidt et al., 2021; Zhu et al., 2012). In this vein, it is reasonable to argue that resource commitment is an important antecedent of GSCM practices. Therefore,

H8. Resource commitment by firms is positively related to the adoption of GSCM practices by firms.

As we have previously argued that environmental regulations will be positively related to the resource commitment of firms (H3), we further argue that:

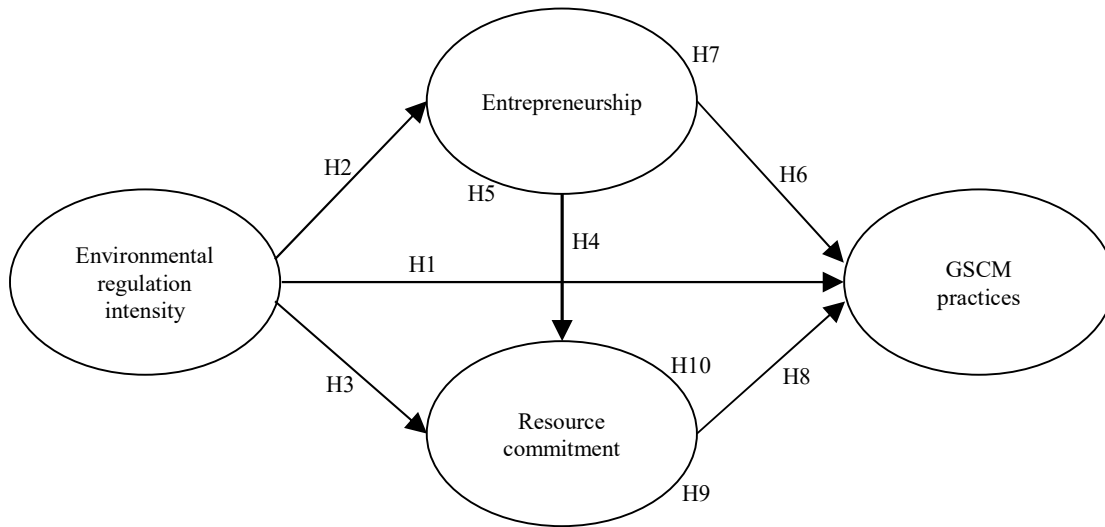
H9. Resource commitment by firms mediates the relationship between environmental regulation intensity and the adoption of GSCM practices by firms.

Moreover, we have previously argued that the entrepreneurship of firms is positively related to the resource commitment of firms (H4). Therefore, we further argue that:

H10. Resource commitment by firms mediates the relationship between entrepreneurship of firms and the adoption of GSCM practices by firms.

Figure 1 shows the hypothesized relationships in a theoretical model.

Figure 1. Theoretical model



4. Research method

4.1 Sample and data collection

To test the research hypotheses, we employed an online questionnaire survey to collect the data from the manufacturing industry in China. As the main polluters and resource consumers in China, manufacturers have been under particularly high pressure to implement environmental management practices such as GSCM (Zhu et al., 2013b). Hence, manufacturers have the biggest potential for GSCM adoption. Moreover, China has the world's largest manufacturing capacity with 30% of the world's manufactured product value (about 4.97 trillion U.S. dollars) (The State Council Information Office of China, 2022). Therefore, the data collected will better represent the GSCM practice of firms in the contemporary world.

We administered the questionnaire via Chinese mobile social network WeChat groups using a purposive sampling method (see also Christmann and Taylor, 2001). From January 27 to February 7, 2022, the online questionnaire hyperlink was sent to selected WeChat groups of alumni of three Universities based in the Guangdong province of China (Guangdong University of Technology, Guangdong University of Foreign Studies, and Guangzhou University of Chinese Medicine) and the WeChat groups of local enterprises based in Guangdong province. Guangdong province is also known as the “world's factory” and accounted for about 13% of the total Chinese manufacturing value in 2022. The respondents were selected so that they were at middle level management positions or above, based at manufacturing companies in Guangdong. After two rounds of reminders, a total of 290 questionnaires were received, of which 231 were usable. The respondent sample includes various industries ranging from electrical and electronic (13.9%), pharmaceutical (13.9%), chemical (6.5%), automobile (5.6%) to petroleum (0.4%). In terms of company ownership, over half of the companies in the sample are privately owned (69.3%),

14.3% are FDIs (Foreign Direct Investments), whereas only 10.8% are state-owned.

4.2 Scales and items

We adopted the items of the main constructs from existing literature and applied a 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree), except for the items related to the adoption of GSCM practices, which range from 1 (not considering it), 3 (currently considering it) to 5 (successfully implemented). Table 2 shows the main items adopted by the study. The questionnaire was first developed in English. A translation-back-translation procedure was then followed to develop the Chinese version of the questionnaire. The Chinese questionnaire was sent to 3 academics and 7 industry experts from China for pilot testing and consultation to ensure face validity of the measurement items.

Previously, Covin and Slevin (1989) developed a scale to assess entrepreneurial orientation in terms of firms' reliance on innovation, proactiveness, and risk-taking. Building on Covin and Slevin (1989), Anderson et al. (2015) reconceptualized the three components of entrepreneurial orientation into two lower order dimensions, namely entrepreneurial behavior and managerial attitude towards risk. Entrepreneurial behavior refers to the firm-level pursuit of new products, processes, or business models (i.e., innovativeness) with the intended commercialization of those innovations in new product/market domains (i.e., proactiveness). Managerial attitude refers to the inherent managerial inclination at the level of senior managers who are tasked with firm-level strategic choices favoring the pursuit of opportunities with uncertain outcomes (i.e., risk taking) (Anderson et al., 2015). The two-dimensional conceptualization of entrepreneurial orientation (rather than three dimensional) is because proactiveness, which emphasises initiating activities, is closely related to innovativeness and is likely to covary with it (Lumpkin and Dess, 1996). Thus, in this study, the entrepreneurship of firms is measured at the strategic decision-making level with two dimensions — innovativeness (five items) and risk taking (three items) (see also Morris and Paul, 1987).

Environmental regulation intensity was measured on a six-item scale derived from Jaffe et al. (2002), which includes items such as “Our products must comply with the relevant environmental protection provisions of domestic laws and regulations”, “Our products must meet the standards of international environmental protection conventions”, and “Our products must meet the requirements of international environmental standards”. Resource commitment was measured on a six-item scale developed by Liu and Chang (2017), which includes items such as “We invested in technologies for processing used materials”, “We have specialists to manage end-of-life products”, and “We established an environmental management system for material recycling”. Adoption of GSCM practices was measured using a scale modified from the study of Zhu and Sarkis (2004), which includes four dimensions—internal environmental management (4 items), green purchasing (4 items), eco-design (3 items) and investment recovery (3 items).

To test nonresponse bias, we compared the responses of early ($n = 125$) and late

(n = 106) responses received. The results of t-tests showed that there are no significant differences between the two groups. Because we used a one-off cross-sectional survey, common method bias may present an issue (Podsakoff et al., 2003). To address any potential common method bias, first, we randomized the questionnaire questions before sending them out. Second, we conducted the Harman's single factor test on the collected data (Podsakoff et al., 2003). We entered all the construct indicators into an exploratory factor analysis. The result indicated that no single factor accounted for over 50% of the variance, thus the common method bias was not a major concern.

5. Results

5.1 Measurement model

We adopted two-step structural equation modelling (SEM) using AMOS 26 to test our research model. In the measurement model assessment, we conducted reliability and validity tests including item reliability, composite reliability, convergent validity and discriminant validity of main constructs, including environmental regulation intensity, entrepreneurship (a second-order factor with two dimensions — innovativeness and risk taking), resource commitment, and GSCM practices (a second-order factor with four dimensions — internal environmental management, green purchasing, eco-design, and investment recovery) using confirmatory factor analysis (CFA). The model fit indices (see Table 1) suggest a good model fit.

Table 1. Measurement model fit indices

Model fit indices	Values	Benchmark	References
χ^2/df	2.527	<3.00	(Carmines and McIver, 1981)
CFI	0.904	>0.90	(Bentler, 1992)
RMSEA	0.081	<0.10	(MacCallum et al., 1996)

As shown in Table 2, all the Cronbach's α values are greater than 0.70, indicating good construct reliability (Nunnally, 1978). The R^2 values of all items are above 0.30 (Chen and Paulraj, 2004). Moreover, all values of the composite reliability are higher than 0.60, which confirmed the satisfactory composite reliability of the constructs (Fornell and Larcker, 1981). The results also show that all the item factor loadings to the corresponding constructs are higher than 0.60 and significant ($p < 0.001$), and all the AVE (average variance extracted) values are higher than 0.50, thus showing a good convergent validity (Fornell and Larcker, 1981).

Table 2. Construct reliability and Convergent validity

Constructs	AVE	CR	R ²	Factor loadings
Environmental regulation intensity (Cronbach's α = 0.902)	0.594	0.895		
Our products must comply with the relevant environmental protection provisions of domestic laws and regulations			0.492	0.702
Our products must meet the standards of international environmental protection conventions			0.903	0.950
Our production must meet the requirements of international environmental standards			0.894	0.945
The government provides subsidies related to the implementation of environmental measures of our company			0.378	0.615
The government gives our company tax breaks for implementing environmental measures			0.391	0.626
The government's promotion of environmental protection has a positive effect on our company			0.509	0.713
Resource commitment (Cronbach's α = 0.928)	0.689	0.930		
We invested in technologies for processing used materials			0.579	0.761
We have specialists to manage end-of-life products			0.637	0.798
We established an environmental management system for material recycling			0.757	0.870
We communicate about the recyclability of products across all business functions			0.755	0.869
We have information and know-how relating to material recycling in our industry			0.669	0.818
We have recycling training programs for employees			0.739	0.859
Entrepreneurship				
Innovativeness (Cronbach's α = 0.896)	0.637	0.898		
We favor a strong emphasis on R&D, technological leadership, and innovation			0.547	0.739
Many new lines of products have been marketed in the past 5 years			0.611	0.782
Changes in product lines have usually been quite dramatic			0.716	0.846
Typically, we initiate actions to which competitors then respond			0.648	0.805
We are very often the first business to introduce new products, administrative techniques, processing technologies, etc.			0.664	0.815
Risk taking (Cronbach's α = 0.826)	0.621	0.830		

We have a strong proclivity for high-risk projects			0.515	0.718
We believe that, owing to the nature of the environment, bold, wide-ranging acts are necessary to achieve the firm's objectives			0.624	0.790
When confronted with decision-making situations involving uncertainty, we typically adopt a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities			0.724	0.851
GSCM practices				
Internal environment management (Cronbach's $\alpha = 0.966$)	0.878	0.966		
Commitment of GSCM from senior managers			0.892	0.945
Support for GSCM from mid-level managers			0.907	0.952
Cross-functional cooperation for environmental improvements			0.877	0.937
Total quality environmental management			0.834	0.913
Green purchasing (Cronbach's $\alpha = 0.955$)	0.824	0.949		
Cooperation with suppliers for environmental objectives			0.882	0.939
Environmental audit for suppliers' internal management			0.875	0.935
Suppliers' ISO14000 certification			0.782	0.884
Second-tier supplier environmentally friendly practice evaluation			0.760	0.872
Eco-design (Cronbach's $\alpha = 0.935$)	0.828	0.935		
Design of products for reduced consumption of material/energy			0.801	0.895
Design of products for reuse, recycle, recovery of material, component parts			0.829	0.911
Design of products to avoid or reduce use of hazardous products and/or their manufacturing processes			0.851	0.923
Investment recovery (Cronbach's $\alpha = 0.915$)	0.787	0.896		
Investment recovery (sale) of excess inventories/materials			0.715	0.845
Sale of scrap and used materials			0.819	0.905
Sale of excess capital equipment			0.828	0.910

According to Fornell and Larcker (1981), discriminant validity is satisfactory if all the squared inter-construct correlations are smaller than the AVE values of each construct. The results shown in Table 3 indicate that the squared inter-construct

correlation values between all pairs of constructs are less than the AVE values of the individual construct in the pair, thus suggesting good discriminant validity of the constructs (Fornell and Larcker, 1981).

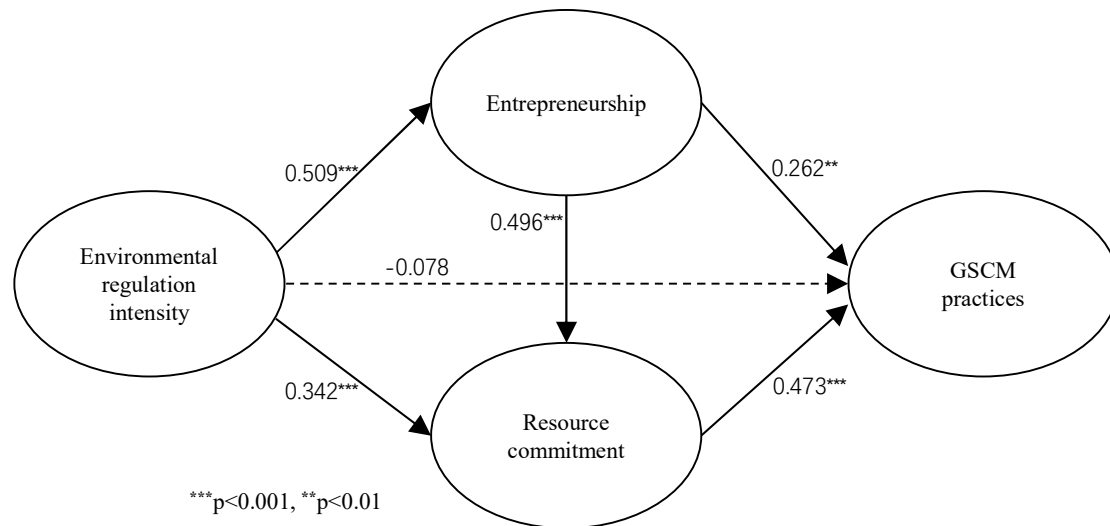
Table 3. Construct discriminant validity

	Environmental regulation intensity	Resource commitment	Innovativeness	Risk taking	Internal Environment management	Green purchasing	Eco-design	Investment recovery
Environmental regulation intensity	0.594							
Resource commitment	0.372	0.689						
Innovativeness	0.276	0.436	0.637					
Risk taking	0.088	0.201	0.389	0.621				
Internal Environment management	0.232	0.406	0.242	0.057	0.878			
Green purchasing	0.061	0.245	0.209	0.109	0.475	0.824		
Eco-design	0.052	0.211	0.230	0.097	0.450	0.643	0.828	
Investment recovery	0.083	0.251	0.177	0.040	0.516	0.527	0.599	0.787
<i>Note.</i> The bold number in the diagonal are AVE values.								

5.2 Estimation of structural model

SEM with maximum likelihood estimation method was used to test the hypothesized direct relationships. The goodness of fit indices of the structural model provided a reasonable model fit ($\chi^2/df=2.083$, CFI=0.929, RMSEA=0.069). Figure 2 shows the path estimates of the structural model for the direct relationships (hypotheses H1, H2, H3, H4, H6, and H8). Environmental regulation intensity has a direct positive effect on entrepreneurship and resources commitment (both at $p < 0.001$), thus H2 and H3 were supported, but the direct effect on GSCM practices was not significant ($p > 0.05$), hence H1 was not supported. Similarly, entrepreneurship has a positive effect on resources commitment ($p < 0.001$) and on GSCM practices ($p < 0.01$), and resources commitment has a positive effect on GSCM practices ($p < 0.001$), thus supporting H4, H6, and H8.

Figure 2. Structural equation model and path estimates



5.3 Mediation test

The bootstrapping approach of Preacher and Hayes (2008) was used to test the mediation effect of entrepreneurship and resources commitment. The mediation test results using estimates of direct and indirect effects are shown in Table 4. The results show that environmental regulation intensity has both a direct impact ($p < 0.01$) and an indirect impact on resource commitment ($p < 0.05$). This significant direct and indirect effect suggests the partial mediation effect of entrepreneurship in the relationship between environmental regulation intensity and resource commitment, thus providing support to H5. Similarly, entrepreneurship has both a direct impact and an indirect impact on GSCM practices (both at $p < 0.01$). This suggests the partial mediation effect of resource commitment in the relationship between entrepreneurship and GSCM practices, thus providing support to H10.

Table 4. Mediation test results

	Direct effect	<i>t</i>	<i>p</i>	Indirect effect	<i>p</i>	Total effect	<i>p</i>
Environmental regulation intensity => Resources commitment	0.342***	4.533	0.000	0.253*	0.019	0.594*	0.015
Entrepreneurship => GSCM practices	0.262**	2.584	0.010	0.235**	0.006	0.497**	0.009
Environmental regulation intensity => GSCM practices	-0.078	-1.033	0.302	0.414*	0.015	0.336*	0.056
Resources commitment => GSCM practices	0.473***	4.567	0.000	-	-	0.473*	0.019
Entrepreneurship => resources commitment	0.496***	5.049	0.000	-	-	0.496*	0.018
Environmental regulation intensity => Entrepreneurship	0.509***	6.765	0.000	-	-	0.509*	0.016
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$							

Moreover, the indirect effect of environmental regulation intensity on GSCM

practices ($p < 0.05$) is positive and significant. In addition, the direct effect of environmental regulation intensity on GSCM practices is negative and not significant ($p > 0.05$). This confirms the mediation effect of entrepreneurship and resource commitment in the relationship between environmental regulation intensity and GSCM practices, thus fully supporting H7 and H9.

Three other SEM models were applied to further verify the mediation effects of entrepreneurship and resources commitment in the relationship between environmental regulation intensity and GSCM practices (see also Sarkis et al., 2010). According to Baron and Kenny (1986), mediation effect exists when all of the four conditions are satisfied: (1) the relationship is significant between the independent variable and the dependent variable; (2) the relationship is significant between the independent variable and the mediator; (3) the relationship is significant between the mediator and the dependent variable; (4) the influence of the independent variable diminishes or becomes non-significant while controlling for the effects of the mediator, which suggest the partial mediation effect or the complete mediation effect, respectively.

The first structural model (Model 1) tests the relationship between environmental regulation intensity and GSCM practices. The second structural model (Model 2) incorporates entrepreneurship as a mediator. The third structural model (Model 3) incorporates resource commitment as a mediator. As shown in Table 5, all the three models have good model fit.

Table 5. Goodness of fit indices of SEM models

	χ^2/df	CFI	RMSEA
Model 1	2.621	0.950	0.084
Model 2	2.191	0.938	0.072
Model 3	2.404	0.938	0.078

The test results shown in Figure 3 indicate that the relationship between environmental regulation intensity and GSCM practice is significant. In addition, the test results shown in Figure 4 indicate that both the relationship between environmental regulation intensity and entrepreneurship and the relationship between entrepreneurship and GSCM practices are significant. Moreover, the influence of environmental regulation intensity becomes non-significant while controlling for the effects of entrepreneurship. This suggests that entrepreneurship completely mediates the relationship between environmental regulation intensity and GSCM practices. Similarly, the test results shown in Figure 5 suggest the complete mediation effect of resource commitment in the relationship between environmental regulation intensity and GSCM practices. Table 6 summarizes the overall hypotheses test results.

Figure 3. Results of Model 1 — Direct relationship

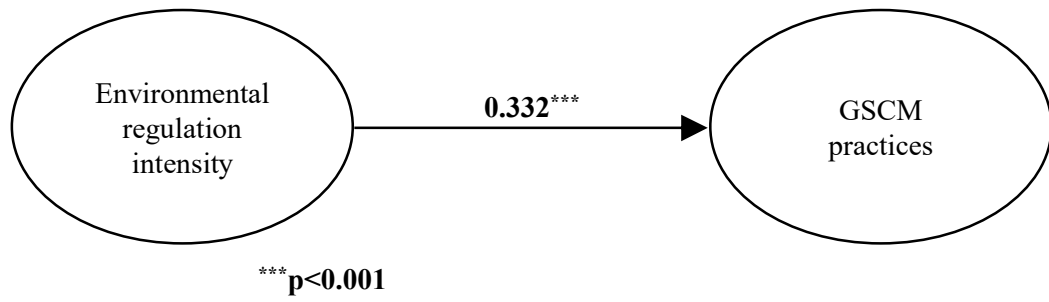


Figure 4. Results of Model 2 — Entrepreneurship as a mediator

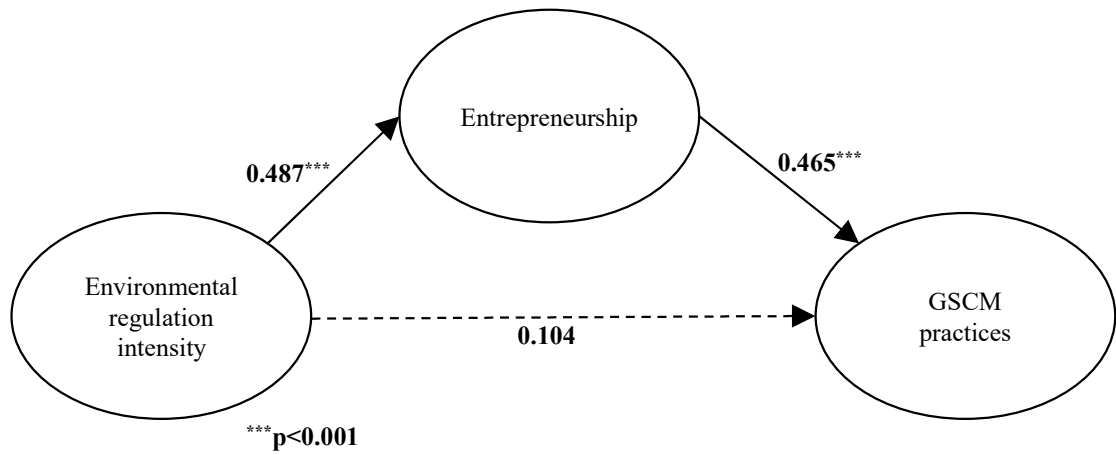


Figure 5. Results of Model 3 — Resource commitment as a mediator

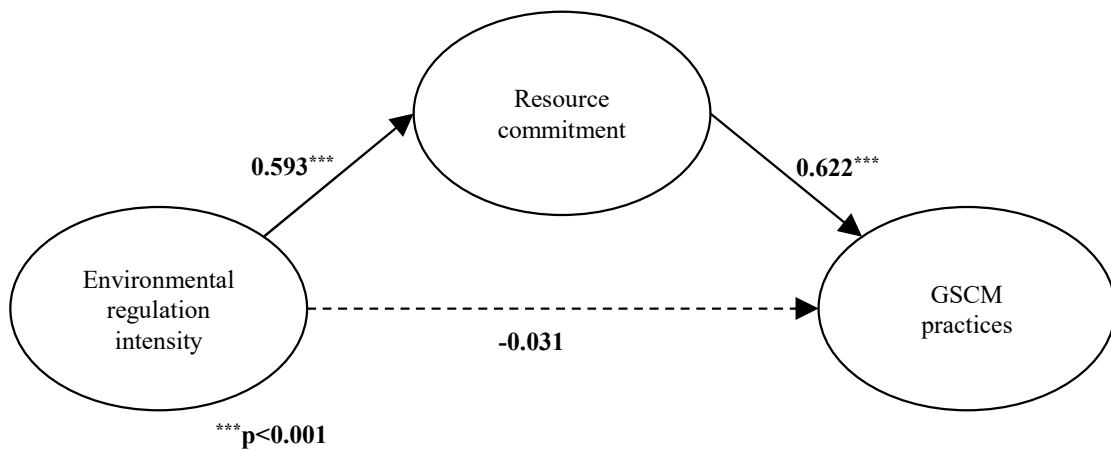


Table 6. Hypotheses test results

Hypotheses	Short description	Supported or not
H1	Environmental regulation intensity is positively related to the adoption of GSCM practices.	No (but significant indirect effect)
H2	Environmental regulation intensity is positively related to entrepreneurship.	Yes
H3	Environmental regulation intensity is positively related to resource commitment.	Yes
H4	Entrepreneurship is positively related to resource commitment.	Yes
H5	Entrepreneurship mediates the relationship between environmental regulation intensity and resource commitment.	Yes (partial mediation)
H6	Entrepreneurship is positively related to the adoption of GSCM practices.	Yes
H7	Entrepreneurship mediates the relationship between environmental regulation intensity and the adoption of GSCM practices.	Yes (complete mediation)
H8	Resource commitment is positively related to GSCM practices.	Yes
H9	Resource commitment mediates the relationship between environmental regulation intensity and the adoption of GSCM practices.	Yes (complete mediation)
H10	Resource commitment mediates the relationship between entrepreneurship and the adoption of GSCM practices.	Yes (partial mediation)

6. Discussion and conclusion

The results show that both entrepreneurship and resource commitment play important mediation roles in the relationship between environmental regulation intensity and the adoption of GSCM practices. Environmental regulations may affect GSCM practices only if they stimulate the entrepreneurship and/or affect the resource allocation of the firms towards GSCM.

The empirical test results suggest that environmental regulations have no significant direct influence on firms' adoption of GSCM. Compared with the environmental practices of a single firm, GSCM involves multi-level, complex, and even cross-border (global) operations. Hence, the direct effect of environmental regulations becomes more difficult to be shown. One possible reason is that modern supply chains transcend national boundaries and operate on a worldwide basis. On the other hand, environmental regulations tend to be heterogenous geographically (e.g., variation across regions and countries) and tend to exert pressure at domestic levels rather than at a global level (Escobar and Vredenburg, 2011), which leads to so called "boundary misalignment" (Greenwood and Suddaby, 2006). For instance, many of the international environmental regulations typically surpass local requirements in China (Zhu et al., 2013b). Thus, at the supply chain level, firms may lag behind when implementing environmental regulations.

Another explanation could be that GSCM is a proactive cross-organizational environmental innovation, whereas firms often perceive regulatory pressures as external drivers of inwardly targeted activities (e.g., direct emissions policy) for

regulation-compliance reasons (Le Van et al., 2019; Zhu et al., 2013b). Only those firms with internal drivers (i.e., entrepreneurship and resource commitment) will identify the internal logic between GSCM and competitiveness and take up beyond-compliance environmental initiatives for greening their supply chains.

Our results also show that more entrepreneurially oriented manufacturers will be more inclined to deploy their resources towards GSCM practices (Liu and Chang, 2017). In this sense, environmental regulations may stir entrepreneurship and the subsequent resource commitment, and consequently GSCM practices. These factors (environmental regulations, entrepreneurial orientation, resource commitment, and GSCM practices) and their interactions provide a micro level explanation of the mechanisms through which institutional pressures will transfer into the GSCM practices of firms.

6.1 Theoretical implications

Drawing on institutional theory, this study further explicates the micro-foundations of firms' adoption of GSCM practices through examining the relationships between environmental regulation intensity, entrepreneurship, resource commitment and the adoption of GSCM practices.

The empirical evidence gained from Chinese manufacturers suggests that there is no direct effect of environmental regulation intensity on the adoption of GSCM practices. However, the effect of environmental regulation intensity is mediated by the entrepreneurship and resource commitment of firms. Therefore, environmental regulations are more able to stimulate the green activities of firms possessing important entrepreneurship orientations such as innovativeness and risk-taking. Moreover, environmental regulations can better stimulate the green activities of firms that are more willing to commit important resources and invest in GSCM. The findings of this study thus highlight the critical role of entrepreneurship and resource commitment in converting external regulation pressures into environmental behavior.

Although previous studies have examined how environmental regulations affect firms' GSCM practices (He et al., 2019; Wu et al., 2012; Zhu et al., 2013b), few studies have investigated the role of entrepreneurship and resource commitment as the micro-foundations of firms' environmental practices. This study hence extended the understanding of the micro-foundations of firms' environmental practices. Although environmental regulations will be very important in shaping the institutional environment, the actual adoption of environmental practices also depends on some important firm qualities. In this study, we found that firms' entrepreneurship, encompassing innovativeness and risk-taking, and their readiness to deploy necessary resources are identified as the micro-foundation of GSCM practices enabled by environmental regulations. This finding echoes Zhu et al. (2012) and sheds light on why, under the same institutional environment, there are distinct adoption approaches and levels of GSCM adoption in different firms.

Furthermore, the sequential relationship identified between environmental regulation intensity, entrepreneurship, resource commitment, and GSCM practices of

firms also explicate an important internal mechanism of how institutional pressures will convert into actual environmental practices of firms. This enriches the application of institutional theory in the GSCM field by providing an understanding of the pathways of institutional isomorphic changes.

6.2 Implications for practice

This study provides important practical implications for both manufacturers and policy makers. First, managers and policy makers need to be aware that adequate resource commitment is critical to the adoption of GSCM practices. Hence, the readiness of firms to adopt GSCM can be assessed by the resource commitment levels of firms. This is very important, because policy makers often push out the environmental regulations on a whole regional or national basis, without much consideration of the differing resource availability of firms. Understanding the readiness of resource commitment of firms will allow more accurate assessment of the policy appropriateness and enable facilitation of more targeted policy development. Second, entrepreneurship orientation in terms of innovativeness and risk-taking may encourage resource commitment by firms and adoption of GSCM beyond the regulation-compliance level of practice. Therefore, the development of entrepreneurship can be one of the most important nodes in the effort of promoting GSCM. Policy makers and regulators attempting to facilitate GSCM practices should not overlook the crucial role of entrepreneurship. They may establish environmental regulations which will be more conducive to nurture firms' entrepreneurship in terms of innovativeness and risk-taking, so that firms will be more willing to commit their resources in innovative approaches to environmental practices.

6.3 Limitations and future research

This study has its limitations, which deserve further research. First, this study followed a cross-sectional research design through a questionnaire survey. However, the effect of environmental regulations on the environmental practices of firms may take time to be observable. Thus, we recommend longitudinal studies in the future to examine the longer-term effect of environmental regulations on the adoption of GSCM. Second, firms in different industries face different degrees of environmental regulation pressure (e.g., electrical and electronic vs. petroleum). Moreover, the entrepreneurship of firms with different ownership structures (e.g., state-owned vs. FDI) will exhibit different characteristics. Therefore, it is worthwhile to further study the practices of GSCM firms in different industries and with different ownership structures. This will allow finer-grained understanding of the relationships between environmental regulations, entrepreneurship, resource commitment, and GSCM practices.

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