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Green supply chain management in Chinese firms: Innovative measures and the moderating role of quick response technology

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Abstract
The last decade has witnessed a sharp rising trend in environmental awareness and protection in China. Green supply chain management (GSCM) has been regarded as an effective tool in China for mitigating the negative effects that firms have on the environment. However, the extent to which GSCM pressures influence GSCM practices, and whether and how GSCM practices affect GSCM performance are topics that remain under-explored. Combining Institutional Theory, Resource-Based View (RBV) Theory, and the literature on GSCM, our study sheds light on the relationship among GSCM pressures, practices, and performance under the moderating effect of quick response (QR) technology. Using statistical analysis of the collected data and case studies from companies in China, we establish several results. First, among different GSCM pressures, market and export pressures have significant impacts on GSCM practices, whereas cost pressure does not influence GSCM practices significantly. Second, internal improvement practice exerts a significant impact on GSCM practices, while external improvement practice negatively affects positive economic performance. In addition, ecology practice has significantly influenced environmental, positive economic, and operational performance. Third, QR technology suppresses the positive effect between internal improvement practice and negative economic performance. Two real cases from Huawei (telecommunications technologies) and Beijing Benz Automotive (automobile manufacturing) are conducted to verify the findings and generate additional insights. Our findings contribute to the literature and provide guidance to help governments and companies establish effective and innovative GSCM policies.

KEYWORDS
green supply chain management, multi-methodological research, performance, practice, pressures, quick response

1 | INTRODUCTION

1.1 | Background

Environmental sustainability is a global concern. For a long time, governments, academies, and enterprises have considered the trade-off between economic growth and environmental preservation and sought out optimal strategies (Bansal & Roth, 2000; Linton, Klassen, & Jayaraman, 2007; Sun, Wang, & Li, 2018; Tachizawa & Wong, 2015; Zhu & Sarkis, 2004). The World Environmental Conference (WEC) has been held annually since 2008. As a global summit, the WEC mandates that all countries turn their development models into green and ecological ones, and deal with deteriorative environmental problems during the process of economic development. Meanwhile, with great public awareness of environmental protection, enterprises are facing more significant environmental protection pressure from the outside. Hence, it has become mandatory for enterprises to adjust their existing production modes to meet the demands of environmental protection and ensure their corresponding image as protectors of the environment (Angell & Klassen, 1999). With the increasing environmental pressure, companies try to seek sustainable operations management modes (Florida & Davison, 2001; Kleindorfer, Singhal, & Wassenhove, 2005), exert corporate social responsibility efforts (Mishra & Modi, 2016), and adopt new measures to reduce the impacts of their production activities on the environment (Khuntia, Saldanha, Mithas, & Sambamurthy, 2018; Li, Zheng, Ji, & Li, 2018). Among all of these new strategies, green supply chain management (GSCM) is considered an important way to attain environmental sustainability (Zhu, Sarkis, & Geng, 2005).

GSCM utilizes all resources in the supply chain with environmental awareness, including product development, sourcing and purchasing, production, distribution, and reverse logistics (Chan et al., 2016; Sundarakani, Souza, Goh, Wagner, & Manikandan, 2010). Prior studies, such as Angell and Klassen (1999), Melnyk, Sroufe, and Calantone (2003), and Geyer and Jackson (2004), have investigated GSCM pressures and performance to an extent. Based on their findings, firms have implemented GSCM to deal with various pressures, such as external regulations, market demand, and exportation requirements, whereas other firms may regard GSCM as an important symbol of whether an enterprise can improve its competitiveness at the present stage. Nonetheless, the extent to which these pressures affect the implementation of GSCM practices and the extent of influence on firms' competitiveness brought on by GSCM practices are topics under-explored in the literature.

China is facing problems when implementing GSCM. As "the world's factory," China has been dealing with the rapid growth of industrial manufacturing for the last two decades. Related activities, such as those of the chemical and textile industries, have introduced serious threats to the environment, thus, forcing the government to face both great opportunity and the challenge of environmental protection. It has been reported that in the last 20 years, the loss of total GDP caused by environmental pollution and ecological degradation has been 7–20%. In 2012, the number of conflicts caused by environmental problems reached 51,000. Among these problems, the enterprises' production activities have played an increasingly significant role in environmental degradation. In 2013, half of 197 rivers under observation were polluted by ammonium nitrate, petroleum, and other industrial raw materials, and among the 287 observed cities, only a small part (less than 5%) of the air quality met the environmental criterion (Ministry of Environmental Protection of China, 2013).[1] For these reasons, the Chinese government has put more pressure on the enterprises to reduce their negative influence on the environment. Meanwhile, as a major link in the global supply chain, China is much obliged to practice GSCM, not only inside the country, but also on the international stage. At the same time, external pressures from exports have pushed Chinese enterprises to apply GSCM practices. However, relevant discussions in the literature concerning firms' GSCM pressures, which drive innovative GSCM practices in China, as well as how GSCM practices affect GSCM performance, are still insufficient.

In recent years, quick response (QR) technology has been used by Chinese firms as an innovative strategy to gain competitiveness when implementing GSCM, especially in the clothing, information technology (IT), and automobile industries (Li, Lim, & Wang, 2019; Zhu & Sarkis, 2004). QR is a technology-driven measure related to how fast enterprises react to unexpected changes in the environment, while still being able to achieve their targets (Cachon & Swinney, 2009, 2011). As a technique commonly used in operations management, manufacturing industries throughout the world are now increasingly aware of the importance of quick responsiveness in solving environmental problems (Klassen & Angell, 1998). In a recent study, Choi and Cai (2018) analytically prove that a shortened lead time affected the environment in apparel supply chains. In response to increasing environmental and social issues, firms have chosen to adopt GSCM strategies and practices (Zhu & Sarkis, 2004). Inspired by Drazin and Schoonhovenm (1996),[2] the innovative measures used in this paper refer to the ways and means of advancing practices and applications of ideas for improved processes, products, technologies, services, or business models towards GSCM. Such measures can also be viewed as the implementation of better solutions to meet environmental sustainability through GSCM, including practices for achieving better GSCM and advanced technology for solving environmental problems. Thus, we have taken a novel perspective by considering the moderating role of QR to investigate such innovative measures as well as more effective GSCM. Nevertheless, to the best of our knowledge, the innovative strategy of employing QR as a part of firms' GSCM implementation and its moderating role on GSCM performance have not been adequately investigated in the literature.

1.2 | Major findings, contribution statement, and organization

China is one of the most promising emerging economies. Many innovative measures including GSCM practices and QR technology are widely applied in China. We explore relationships among GSCM performance, practices, and pressures (GSCM-3P), under the moderating influence of QR. Drawing upon Institutional Theory, Resource-Based View (RBV) Theory, and a review of the existing literature, this study contributes in three ways. First, we theorize and empirically examine how GSCM pressures and practices interact with each other to affect GSCM performance in the context of Chinese companies. Our findings enrich the understanding of specific factors among GSCM pressures that affect GSCM practices, and generate some interesting and new results which complement prior literature (Zhu, Sarkis, & Lai, 2007). Second, we demonstrate the interactive relationship between GSCM practices and performances, and identify the specific factors of GSCM practices that are beneficial to firms' GSCM performance. Hypothesizing that GSCM practices and performances are interrelated, based on Institutional Theory, the relationship between GSCM practices and performances is investigated via structural equation modeling (SEM) analysis, which complements the GSCM literature. We also illustrate the different effects of GSCM in Chinese companies. Third, our findings provide scientifically sound support for some topics, such as the moderating effects of QR and the effects of GSCM practices on firms' GSCM performance. Additionally, we draw some significant conclusions and propose corresponding suggestions for both the government and Chinese enterprises. Specifically, we suggest that the government impose customized measures on different industries, help enterprises innovatively transform their operational modes, and enhance their environmental performance. Meanwhile, the government may implement some innovative measures to influence the market (e.g., encouraging environmental-friendly consumption, educating the public and promoting awareness about environmental protection). We further suggest that companies strengthen their ecological practices, such as resource recycling and eco-design. This not only helps to enhance business performance, but also contributes significantly to the environment and resource utilization.

The remainder of this paper is arranged as follows. Section 2 reviews related theories. Section 3 proposes the study's hypotheses. Section 4 presents the data collection and processing details. Section 5 presents the empirical analysis and findings. Section 6 reports case studies on two real-world companies in China. Section 7 is devoted to managerial implications and other further discussions. Section 8 concludes the paper and proposes future studies. Tables and figures (except Figure 1) are placed in Appendices (A) and (B).

2 | THEORETICAL BACKGROUND

2.1 | Green supply chain management

GSCM aims to maximize resource utilization throughout the whole supply chain while minimizing its negative impact on the environment. In the literature, Srivastava (2007) identifies GSCM as an integrated environmental protection concept covering the full the supply chain, from product development to manufacturing and final distribution. Zhu et al. (2007) claim that GSCM might be considered from the source of green supply chain procurement to producers and consumers. In the context of GSCM, firms' practices follow different environmental strategies according to their resources and capabilities (Bowen, Cousins, Lamming, & Farukt, 2010; Zhu & Sarkis, 2004; Zhu et al. 2005, 2007).

The relationships among GSCM pressures, practices, and performance have attracted attention ever since enterprises and researchers realized that environmental protection management was not confined within organizations, but rather required collaboration between organizations for implementation. Previous studies have focused on this topic from different perspectives (Melnyk et al., 2003). For example, Montabon, Sroufe, and Narasimhan (2007) testify that environmentally conscious management practices affect a firm's performance. Zhu and Sarkis (2004), Zhu et al. (2005, 2007) and Zhu, Geng, Fujita, & Hashimoto, (2010) have conducted some related studies in this field, including situations of GSCM in China (2004), how Chinese enterprises perceive GSCM (2005), practices of GSCM in specific industries like the automobile industry (2007), and the comparison of China and Japan in terms of GSCM practices (2010). From the perspective of ecological modernization, Zhu, Geng, Sarkis, and Lai (2011) further study the impacts of GSCM on environmental performance.

GSCM in China has been explored in the operations management (OM) literature. With modeling analysis, taking China as the background, Wang, Lai, and Shi (2011) establish an analytical GSCM optimization problem and find it to be an effective and novel tool for green supply chain strategic decisions. Krass, Nedorezov, and Ovchinnikov (2013) establish a profit-maximization model involving environmental taxes. The authors study how the taxes make the supply chain much greener by reducing emissions and improving the environment. In addition, other researchers have studied production and operations management challenges based on green network configuration problems (e.g., Fleischmann, Beullens, Bloemhof-Ruwaard, & Van Wassenhove, 2001; Savaskan, Bhattacharya, & Wassenhove, 2004).

Many prior studies have examined relationships among GSCM-3P from different viewpoints and some have obtained valuable findings. Debates still exist, however, on whether and how applying GSCM can affect company operations and whether innovative GSCM practices can promote or restrain firms' economic performance, especially in developing countries. This is an obvious gap that this paper aims to fill.

2.2 | Institutional Theory

Institutional Theory explores how external pressures drive a company to implement organizational practices (Dacin, Goodstein, & Richard, 2002). According to Institutional Theory, isomorphic drivers can be classified into three different groups, namely, the coercive group, the normative group, and the mimetic group (DiMaggio & Powell, 1983). Coercive pressures, often exerted by external entities (e.g., government, industry and professional networks), are the primary drivers for firms' implementation of environmental practices (Liang, Saraf, Hu, & Xue, 2007). Henriques and Sadorsky (2017) show that governments are also the key promoters of voluntary green operations management practices. In many developed markets, like in the USA, laws and regulations are important coercive pressures that drive firms' green practices. Moreover, Sarkis, Zhu, and Lai (2011) indicate that regulations in developed countries have also raised institutional pressures for companies in developing countries to enhance green operations. Meanwhile, developing countries like China have increasingly enforced strict regulations leading manufacturers to implement GSCM practices, the effects of which are quite remarkable (Zhu et al., 2007).

In terms of normative pressures, consumers in the market are the most important drivers of firms' implementation of GSCM practices (Sarkis et al., 2011). Previous studies have shown that consumers have better environmental awareness in developed countries than in developing countries. Yet, consumers in developing countries are also becoming more environmentally conscious (Vachon & Klassen, 2008). Note that exports to foreign countries also significantly entice manufacturers in developing countries like China to adopt GSCM practices (Zhu et al., 2011). As such, further investigation is still needed regarding how market and export pressures affect GSCM and related operations in developing countries, such as China.

Companies may follow competitors because of their success and successful companies are always regarded as benchmarks in their industry. However, this mimetic pressure can be offset or reduced by the mimetic cost. Prior studies (e.g., King & Lenox, 2001) reveal that agile operations can reduce pollution expenses, which would indirectly reduce wastage of resources. Nonetheless, they focus on exploring the influence of cost pressure on environmental performance. In this paper, we argue that cost pressure (from external sources) can have a negative effect on firms' implementation of GSCM practices.

2.3 | Resource-Based View Theory

Resource-Based View (RBV) Theory argues that firms should enable a collection of resources to enhance their competitive advantages (Barratt & Oke, 2007; Hart, 1995). This theory has typically been adopted by companies as a strategy for creating competitive edges, and may include human, capital, equipment, technology, and information resources. The two categories of resources are, namely, tangible (factory and inventory) and intangible (technology and information) (Sarkis, Gonzalez-Torre, & Adenso-Diaz, 2010). In addition, RBV Theory proposes that "resources should be valuable, precious, rare, inimitable, and non-substitutable" in order to confer a sustainable competitive edge (Barney, 1991). Non-substitution of the most important strategic resources helps a firm maintain its competitiveness because competitors cannot acquire similar resources. Hart (1995) indicates that a purely "internally based" competitive approach should be associated with the issue of external relations. Buysse and Verbeke (2003) believe that GSCM practices are critical for companies to become eco-friendly in business operations, based on RBV Theory.

Another school of thought argues that RBV Theory can help companies form dynamic capabilities (DCs) (Coates & Mcdermott, 2002). DCs refer to the decision makers' ability to update and adjust their resource allocation dynamically (Eisenhardt & Martin, 2000). As a result, we adopt RBV Theory and consider DCs and other strategic factors with the implementation of GSCM and QR.

3 | HYPOTHESES DEVELOPMENT

3.1 | GSCM pressures

"Greening" organization theorists indicate that organizational strategy contains environmental pressures and organizational responses, with the aim of making firms more sustainable (Jennings & Zandbergen, 1995). They show that Institutional Theory can help a firm address environmental issues derived from external pressures. In our paper, GSCM, as an organizational strategy applied to the supply chain, includes GSCM pressures, practices, and performances. GSCM pressures have been extensively investigated, mainly from the perspective of internal and external organizations, and the "stakeholders" (Sarkis et al., 2010). Related studies have shown that organizations and groups put great pressures on enterprises to implement GSCM. Zhu et al. (2011) consider that, for Chinese enterprises, the export and sale of products to foreign consumers are two major drivers prompting them to adopt green operations. Chinese enterprises have also faced environmental pressure when encountering green barriers in the export process. In 2015, the total number of exports in China reached 14.14 trillion dollars, and mechanical and electrical products made up for 8.15 trillion dollars, or 57.7% of the total. In the same period, labor-intensive products like apparel and textiles accounted for more than 2.9 trillion dollars, or 20.7% of the total. Among them, the export of toys, furniture, bags, and plastic products continues to grow. In addition, private enterprises are more active in foreign trade. As a result, their imports and exports have reached 9.1 trillion in the same period, occupying 37% of total imports and exports.[3] With the expanding influence of exports, the pressures faced by enterprises in implementing GSCM should no longer be ignored. For example, for products made of wood, many countries require certificates to prove that the manufacturing process does not affect the sustainable development of forest resources. However, many Chinese enterprises are unable to provide such certificates, so their products cannot be exported. As another example, a shoe company in Fujian Province has products that cannot be exported because materials employed in the production process fail to pass the environmental rules set by the importing countries. There is no doubt that Chinese enterprises must improve their environmental performance and meet the export requirements of importing countries.

Consumer pressure is another source of pressure experienced by Chinese enterprises. For example, Chan and Lau (2001) compare Chinese and American consumer purchasing behaviors, and conclude that American consumers are more likely to translate the intention of green purchasing into action. In fact, with increasing consumer awareness of environmental issues, "green" purchasing has become a major trend along with companies desiring to make their products "green" (Min & Galle, 1997). Hence, for this market segment, whether a product is green or not determines its competitiveness.

In addition, pressure from government policy also affects the GSCM practices of Chinese enterprises. Specific measures such as environment taxes have been imposed to regulate the consumption of certain resources, like water usage (see, for example, Bai & Hidefumi, 2001). Recently, there have also been frequent environmental pollution accidents, ranging from water pollution to chemical leakage, so the government continues to face mounting pressure. Correspondingly, scholars are exploring how corporate social responsibility affects the environment and the enterprises' performance (Mishra & Modi, 2013; Modi & Mishra, 2011). For instance, there are arguments saying that resource efficiency has positive effects on enterprises' financial performance. Thus, considering consumers' increasing environmental awareness, it has become critical for enterprises to implement GSCM under consumer supervision and government pressure.

In recent years, many foreign enterprises have set up manufacturing operations in China, although key components employed in production are mainly from their home countries. In many cases, this is because Chinese enterprises cannot provide materials that meet the environment-related rules and requirements of importing countries (Liu & Diamond, 2005). In fact, large enterprises from developed countries evaluate not only their direct vendors, but also all other tier members along the supply chain. In the literature, Walton, Handfield, and Melnyk (1998) propose 10 criteria for green supplier evaluation, among which the criteria for the second-tier supplier's sustainability are considered to be most important. In this paper, we group the pressures above (consumers, policies, and suppliers) into the market factor and study their influences on GSCM practices.

Costs associated with implementing GSCM form another kind of pressure that enterprises experience. Such costs include: waste disposal, raw materials, production, and management. From the perspective of Transaction Cost Economics (TCE) Theory, it is crucial to figure out the effort and costs required, and this can affect the completion of an activity carried out by entities such as the manufacturer or retailer (Ketchen Jr & Hult, 2007). Thus, we argue that all costs are a potential obstacle against the adoption of GSCM practices. For example, in the clothing industry, the waste water produced during production is a big source of water pollution. Although this problem has existed for a long time due to high disposal cost, it has been ignored in most studies. To study the pressures of GSCM in this paper, we include "cost" as a factor. Based on the literature above, we introduce the following hypothesis:

Hypothesis 1 Chinese enterprises are affected by varying degrees of pressures due to environmental issues, where export is the main pressure.

3.2 | GSCM practices

With reference to the literature, this paper considers three GSCM factors (internal improvement, external improvement, and ecology) in the analysis. These three factors represent the main organizational activities, both external and internal (see Zhu and Sarkis (2004) for more details). External improvement involves different kinds of support from the external arms of the organization, mainly the management and maintenance of suppliers. On the other hand, internal improvement consists of different kinds of activities within the organization to improve environmental performance, such as training the staff, achieving ISO 14001 certification, implementing waste disposal systems, and maintaining support from the managers. The ecology factor includes a series of sustainable and innovative measures, such as the recovery of products and resources, and the use of eco-design based on sustainability principles (Sarkis et al., 2011).

External GSCM practice is significant for enterprises. As we all know, support from the operations manager is necessary, and ultimately affects the success of deploying innovative measures. Zhu and Sarkis (2004) explore the positive relationship between green operations and the operations manager's consciousness. They show that communication with outside GSCM experts is crucial to ensure the success of GSCM implementation. In addition, according to Pinto, Pinto, and Prescott (1993), enhancing cross-functional cooperation can facilitate the implementation of environmental projects in companies. As supply chain management (traditionally viewed as external GSCM practice) is increasingly important, Zsidisin and Hendrick (1998) identify the critical success factors for achieving environmentally friendly purchasing operations.

Internal GSCM systems also play a crucial role (Zhu et al., 2005). The waste disposal system, the environmental management system, and the eco-labeling of products all have direct effects on an enterprise's environmental performance; they also represent the direct behaviors of the enterprises when facing GSCM pressures. Note that this topic has been explored in the literature (Zhu et al., 2007).

Ecology is also a burgeoning factor that "makes a difference" to GSCM practice. Many enterprises in the United States and Europe consider resource recovery and recycling to be an important embodiment of GSCM (Zsidisin & Hendrick, 1998). In China, in order to encourage resource recycling and green product design, the government has imposed taxes on some resources (e.g., coal and natural gas) instead of providing resource subsidies. Note that the impact the product has on the environment is determined at the product design stage (Hart, 1997). Based on the above reviewed literature, we propose the following hypotheses:

Hypothesis 2a The market pressure promotes GSCM practice.

Hypothesis 2b The cost pressure inhibits GSCM practice.

Hypothesis 2c The export pressure promotes GSCM practice.

3.3 | GSCM performance

Prior studies have examined how GSCM affects channel performance (Montabon et al., 2007; Walls, Berrone, & Phan, 2012). Economic performance is reflected by the increase or reduction of materials purchasing, energy consumption, and waste disposal (Ullmann, 1985). Operational performance usually refers to an increasing amount of timely-delivered goods, reduced inventory levels, reduced defective rates, and enhanced equipment utilization. Some literature has shed light on how channel relationships may improve environmental performance (Handfield, Walton, Sroufe, & Melnyk, 2002). Such positive relationships are strongly supported by the literature. For example, Zhu and Sarkis (2004) assert that internal cooperation within enterprises can lead to the improvement of environmental performance. Vachon and Klassen (2008) believe that working closely with vendors benefits the adoption of new technologies in protecting the environment. In addition, mutual cooperation and communication among employees, customers, and suppliers also helps to improve environmental performance.

It is still contentious, however, whether GSCM practice leads to or is associated with negative or positive economic performance. For example, Alvarez Gil, Jimenez, and Lorente (2001) point out that GSCM is positively correlated with the economic performance of companies. Dyer and Singh (1998) argue that the relationship between GSCM practices and the organization's economic performance provides a mechanism to promote trust and reduce risks. The authors believe that this mechanism can eventually improve innovation and profitability. However, Bragdon and Marlin (1972) conclude that, in terms of economic performance, enterprises do not reap profits and sales performance for their environmental management costs.

Research on the relationship between GSCM practice and operational performance is relatively limited, and only a portion of that research has shown a positive relationship between the two factors. Klassen and Mclaughlin (1996) point out that, for enterprises, strong environmental management is beneficial for financial performance. Darnall and Edwards (2006) show that environmental management practices can help enterprises improve internal operations and operation efficiencies. Based on the above literature, we present the following:

Hypothesis 3a The external improvement practice promotes enterprise performance.

Hypothesis 3b The internal improvement practice promotes enterprise performance.

Hypothesis 3c The ecology practice promotes enterprise performance.

3.4 | The moderating effect of quick response

QR, as a moderator between the internal and external arms of an enterprise, is identified as the innovative technology made by an enterprise for shortening lead times in production and distribution to achieve a better supply–demand matching (Cachon & Swinney, 2011). Thus, based on the above literature, we use in this paper the fast production mode and logistics as the proxies for QR, resulting in a shortened lead time (detailed in Table A3). Qi, Zhao, and Sheu (2011) confirm that environmental volatility is a key factor in determining supply chain strategies. Thus, whether QR can help an enterprise avoid environmental uncertainty and further promote performance, and whether it can affect the relationship between GSCM practice and performance is a noteworthy and innovative topic for further exploration.

We have already proposed the hypotheses that GSCM practice is usually beneficial to environmental performance, economic performance, and operational performance. Moreover, we hypothesize that the level of enterprise performance improvement may be related to QR. The operating management mode, including QR, usually helps to improve operational efficiency (Fullerton, McWatters, & Fawson, 2003; Kannan & Tan, 2002; Samson & Terziovski, 1999). Although it seems that QR may not have a clear correlation with environmental performance, QR may help to shorten the logistics time (e.g., transportation and handling), and therefore, affect environmental performance (Hart, 1995).

There are many studies on the effects of QR on enterprises' economic and operational performances. However, this paper focuses on whether QR plays a moderating role between GSCM practices and performances. As such, we take QR as a moderator to investigate its effects on the relationship between the firms' GSCM performances and practices.

QR can be a bane or boon to the environment. In a study of North American and Japanese automobile companies, Rothenberg, Pil, and Maxwell (2001) argue that QR can lead to increased emissions of "volatile organic compounds," which questions the efficiency of using paint and cleaning solvents. Klassen (2000) regards QR as a helpful tool in pollution control, especially when two measures are used at the same time. King and Lenox (2001) analyze a huge number of American enterprises established between 1991 and 1996, and find that QR helped these enterprises effectively reduce waste and pollution.

Earlier studies, such as Macdonald (1991), have shown that QR can cause adverse effects on the environment. QR requires high flexibility of stock and assembly lines so the effects on the environment during the manufacturing and transportation processes may be inevitably ignored. Thus, the environment may be harmed in meeting the QR standard. King and Lenox (2001) point out that in enhancing the efficiency of QR, small batch production can help to reduce waste and lead to better disposal of unused process materials. Related research and findings on QR's impacts have also been published (see Choi & Sethi, 2010; Choi, Zhang, & Cheng, 2018; Iyer & Bergen, 1997).

By comparing over 200 companies, Michael and Wempe (2002) report that QR adopters financially perform better than non-adopters. However, the authors also point out that, for small businesses, QR does not help to improve economic performance. Mia (2000) states that firms can increase their profits by adopting QR in their production process. Dong, Carter, and Dresner (2001), meanwhile, believe that QR can lead to a reduction of the buyer's costs. In addition, by comparing the performance of QR adopters and non-adopters in two different departments, Callen, Fader, and Krinsky (2000) find that enterprises should improve their QR abilities in order to achieve greater productivity, better inventory performance, lower total costs, and higher profits. The direct goal in implementing a QR strategy is to reduce the storage cost and improve the on-time delivery rate. The improvement of operational performance is the direct motivation for enterprises' implementation of QR. Therefore, this paper holds that QR has a positive effect on the economic and operational performances of enterprises. Based on this review of the literature, we propose the hypotheses below and present the overall conceptual framework for this study in Figure 1.

Hypothesis 4a Implementing the QR strategy reduces the positive effects of GSCM practice on environmental performance.

Hypothesis 4b Implementing the QR strategy enhances the positive effects of GSCM practice on positive economic performance.

Hypothesis 4c Implementing the QR strategy reduces the positive effects of GSCM practice on negative economic performance.

Hypothesis 4d Implementing the QR strategy enhances the positive effects of GSCM practice on operational performance.

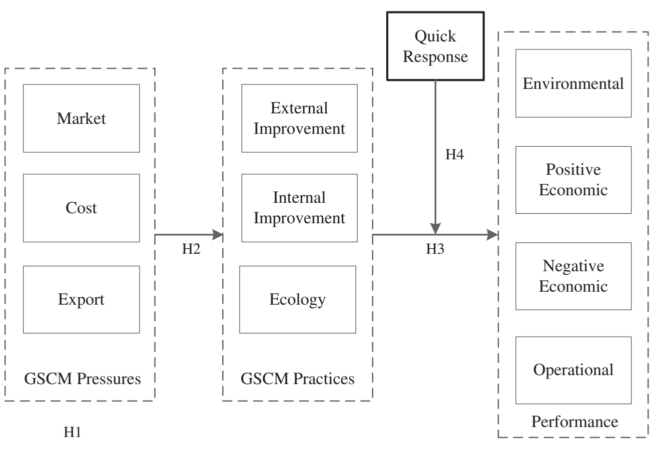

FIGURE 1 Conceptual research framework for this study

4 | QUANTITATIVE ANALYSIS

4.1 | Data source

4.1.1 | Measurement scale refinement

To examine the proposed hypotheses, we collected data from various companies and conducted a questionnaire-based survey in the present study. Extending and improving the questionnaire of Zhu et al. (2005), we modified the items based on the literature and our research objective. This modification resulted in a final questionnaire containing four parts. The first part collected basic information about each enterprise, including its type, size, income, age,[4] and job position of respondents. The second part was about GSCM pressures and contained 18 items. The third part concerned GSCM practices with 22 items and QR with three items (production model and logistics). The fourth part addressed the enterprises' performance with 22 items. In parts 2, 3, and 4, responses were collected using 5-point Likert scales that were unique to each part (**see Table A1**). To ensure that the respondents understood the details, we offered them a briefing before the start of each survey section.

4.1.2 | Data collection

The data were collected in two steps, as described below:

Questionnaire distribution

We strategically collected our primary data mainly from processing and manufacturing companies located in four well-developed manufacturing areas in China: Beijing–Tianjin–Hebei Region, Shanghai–Zhejiang Region, Guangdong and Yunnan Provinces. We randomly sampled processing and manufacturing companies from the Chinese government's National Bureau of Statistics (NBS), which covers a vast set of industries, including automotive, electronic, chemical/biological, iron, clothing, food, etc. We chose a senior operations manager from every target company and a total of 1,000 operations managers agreed to participate in our research. The research unit was the individual enterprise and its supply chain. Following the operations management literature (Carlson & Kacmar, 2000; Chan et al., 2016), we mailed the questionnaires to the sampled firms with a document explaining the objective and importance of the study. After the mailing and again, 3 days later, we made follow-up calls to clarify the research details and explain to the firms the importance of receiving their responses. We also guaranteed that we would provide them with the final reports at the end of the study.

Usable questionnaires and missing data analysis

Initially, 1,000 questionnaires were distributed and 482 responses were collected (response rate = 48.2%). To ensure quality, we deleted 99 invalid questionnaires with more than two-thirds of consecutive identical answers (valid response rate = 38.3%; full response rate = 33.8%; partial response rate = 4.5%). Following Newman (2014), we used the pairwise deletion method for treating the missing data, since the "item level missingness" issue appears in partial responses, valid response rate is bigger than 30%, and partial response rate is smaller than 10%. The respondents came from state-owned, joint-venture, foreign, and private enterprises and most of the enterprises had a size of more than 100 staff members at the time of survey.

4.2 | Statistical description

The data we collected can be classified based on enterprise type, size, income, age, and position of respondents. **Table A2** demonstrates the distribution of the respondent firms.

Figure A1 illustrates that enterprises in the automotive, electronics, and IT industries accounted for nearly 50% of the sample. In terms of property, state-owned and private enterprises comprised 39.27% and 31.41% of the sample, respectively. Most of the respondent enterprises were located in the north district, indicating a concentrated distribution. We performed a reliability analysis for the multi-item scales. Because the tau-equivalency assumption of the widely used Cronbach's α reliability test is not satisfied in our data, we employed another reliability analysis method recommended by Cho (2016). Following Cho (2016), the measurement model we used corresponds to the correlated factors model and the suggested reliability measurement is called "correlated factors reliability." Then, we obtained the model reliability coefficient (i.e., .973) and the factor reliability coefficients ranging from .720 to .923 (**detailed in Table A4**). Therefore, the data has a sufficiently high level of reliability.

For convenience, we used codes to mark the measured variables. The corresponding relationships are listed in **Table A3**. The correlation indexes of GSCM pressures, practices, performance and QR are shown in **Table A4.** The Pearson correlation coefficients showed a significant relationship among GSCM pressures, practices, performance, and QR, which was further investigated through SEM. To address the common method variance (CMV) concern, following Richardson, Simmering, and Sturman (2009), we conducted the correlational marker technique proposed by Lindell and Whitney (2001). The firms' size, age, and income were found to be the least correlated with the criterion factors, thus, we combined these items into the marker variable. Following their steps, the correlation was still significant after correction and the sensitivity analysis confirmed this result ($p < .05$, see Table B1). This indicates that CMV is not present in our data.

4.3 | Factor analysis

This paper employs CFA (confirmatory factor analysis) and EFA (exploratory factor analysis) to help confirm the measured variables' validity and reduce the dimensions of the variables. First, a conformity test was carried out to determine whether the data set was suitable for EFA by applying BTS ("Bartlett test of sphericity") and KMO ("Kaiser-Meyer-Olkin-measure of sampling-adequacy"). The results showed that BTS had a high significance at the .00 level and the KMO's value for all parts of the questionnaire exceeded .9, indicating the validity and good fitness for EFA. Next, we extracted the variables of GSCM pressures, practices, and performances using principal component analysis. Given that the differences among the factor loadings of different groupings were not obvious, we used the factor matrix rotation method to transform the factor matrix and increase the differences among all factor loadings, ultimately increasing the interpretability of all factors. Furthermore, we used varimax rotation to perform the factor rotation. The rotating results of GSCM pressures are listed in Table B2. Through factor analysis, we extracted the variables of the three dimensions of the questionnaire (GSCM pressures, practices and performance) into inferior dimensions. The dimensions of GSCM pressures were: market, cost, and export. These represented 63.71% of the total variance of the original 18 items. The data indicate that these three factors well represent GSCM pressures. Similarly, using the same analysis methodology, we derived the dimensions of GSCM practices: internal improvement, external improvement, and ecology. These three dimensions represented 61.45% of the total variance of the original 22 items (see Table B3). Furthermore, the dimensions of the enterprises' performance were: environmental, positive economic, negative economic, and operational. These four dimensions represented 70.71% of the total variance of the original 22 items, and the corresponding factor rotating results are listed in Table B4.

We then conducted CFA to evaluate the multiple-item measures' validity. The result is shown in Table B5 (degree of freedom = 1933, chi-square = 3,593.306, root mean square error of approximation = .047, probability RMSEA$\leq$.05 = .965, comparative fit index = .907, standardized root mean square residual = .051). We found that all fit indexes are within the acceptable range, and the "chi-square goodness-of-fit" is significant ($p < .001$), as it is quite sensitive to the number of samples. Note that in our study, the "chi-square/-of-freedom ratio is 1.86, which is acceptable (see Jackson, Wall, Martin, & Davids, 1993). All "factor loadings" range from .515 to .874, with *P*-values smaller than .001, which shows that the underlying constructs have "high significance" (see Table B6). All item coefficients are higher than twice their SEs (Flynn, Huo, & Zhao, 2010), supporting adequate reliability and convergent validity. Considering the factor correlations which range from .254 to .602 (see Table A4), we have combined each pair of factors with a correlation larger than .5 into one factor to conduct the chi-square test. The results in Table B5 show that the combined models are significantly worse than the original model, which further confirms our underlying constructs.

5 | RESULTS AND ANALYSIS

5.1 | Quantitative descriptive analysis

We first performed a descriptive statistics analysis to facilitate the subsequent analysis. **Table A3** shows the results of the descriptive statistics analysis, from which we obtain the following findings. For GSCM pressures, the market and cost pressures are the two main drivers influencing the implementation of GSCM, and the mean values are 3.55 and 3.49, respectively. However, the export pressure is lower, with a mean of 3.16. For GSCM practices, the internal improvement practices were applied widely (with mean value 3.43), whereas the external improvement and ecology practices had fewer applications (with mean values of 3.19 and 3.21). As for the influence of GSCM practices on the company's performance, the "environmental performance" was affected the most (mean value = 3.53), whereas positive economic performance was the least significant (mean value = 3.26). Compared vertically, the average values of the variables were all less than 4.

To clarify the differences of GSCM factors in different industries, we have illustrated the results in **Figure A2**. It shows that the pharmaceutical and petroleum industries were more prominent in almost all dimensions. For GSCM pressures, the petroleum industry faced more pressure than the other industries. For the market factor, the petroleum, pharmaceutical, and electronics industries faced more pressure (with means of 4.20, 4.15, and 3.95, respectively). These industries also had a higher export pressure (with means of 4.33, 4.08, and 3.82, respectively). For the cost factor, the petroleum, catering, and electronics industries had a higher pressure (with means of 4.08, 4.05, and 3.96, respectively).

For GSCM practices, the pharmaceutical industry exerted more effort to achieve better GSCM performance. For the external improvement factor, the pharmaceutical, petroleum, and electrical industries were more active in practicing GSCM (with means of 4.25, 3.79, and 3.55, respectively).

For the internal improvement factor, the petroleum, pharmaceutical, and electronics industries practiced GSCM more actively (with means of 4.31, 4.31, and 3.79, respectively), whereas the catering, transportation, and IT industries were less active. For the ecology factor, which involves various innovative measures, our findings show that the petroleum, automobile, and electrical industries were more active in practicing GSCM (with means of 3.88, 3.57, and 3.56, respectively), whereas the food and catering industries were less active. Regarding the QR factor, pharmaceutical, electronics, and automobile industries had a higher degree of practicing GSCM (with means of 4.33, 3.97, and 3.75, respectively).

For enterprise performance, the pharmaceutical industry performed better than other industries. For environmental performance, the pharmaceutical, petroleum, and electronics industries contributed more to the environment after practicing GSCM (with means of 4.29, 4.12, and 3.94, respectively), whereas the transportation and catering industries contributed less. For economic performance, the petroleum, pharmaceutical, and automobile industries showed more positive performance after practicing GSCM (with means of 3.92, 3.58, and 3.48, respectively), whereas the pharmaceutical, food, and catering industries showed more negative performance after practicing GSCM. For operational performance, the electronics, electrical, and pharmaceutical industries were more efficient after GSCM practice (with means of 3.80, 3.66, and 3.57, respectively), whereas the iron and chemical/biological industries were less efficient.

5.2 | Structural equation Modeling (SEM) analysis

Once we had an overall picture of the results, as suggested by Ketokivi (2019), we further used Mplus7 to perform an SEM analysis to confirm our hypothesis findings and uncover the relationships among GSCM pressures, practices, and performance.

We first clarified the independent variables and dependent variables. In the first part, the GSCM pressures were independent variables and the GSCM practices were dependent variables. Accordingly, we investigated how GSCM pressures influenced GSCM practices. In the second part, we regarded the GSCM practices as independent variables and the enterprise performance as dependent variables. The relationship between GSCM practices and enterprise performance was also examined. Then, we investigated the moderating role of QR between GSCM practices and enterprise performance. Note that the sample data stems from 383 Chinese companies, and the firm's organizational type, age, size and income are used as control variables to control the organizational extraneous effects (Simons, Pelled, & Smith, 1999; Zhu & Sarkis, 2004).

In the first part, we assumed that the factors of GSCM pressures (market, cost, and export) were independent of each other. Then, we explored their influence on the factors of GSCM practices (external improvement, internal improvement, and ecology). Similarly, the second part assumed that the factors of GSCM practices were independent of each other. We then investigated how they influenced enterprise performance.

Tables A5 and A6 illustrate the results of SEM. The confidence coefficient of our research is $p = .05$. From **Table A5**, we find that, in GSCM pressures, the market factor had a significant, positive influence on GSCM practices (Sig < .05, $b = .654$, .522, and .236, respectively). This is the main pressure for companies to implement external, internal and ecology practices. The export factor also had a positive influence on GSCM practices (Sig < .05, $b = .179$, .090, and .177, respectively). The cost factor had no significant influence on GSCM practices, contradictory to our hypothesis, meaning that the enablers dominate as opposed to the hindrances. In a prior study on Chinese firms, Zhu and Sarkis (2004) point out that cost (included in the internal driver) contributes significantly to eco-design and resource recovery in comparison to other practices. This supports the positive coefficient of cost to ecology practice, because Chinese enterprises are more sensitive to the cost involved in protecting the environment, ignoring the cost's impact on the implementation of external and internal enhancement practices. In addition, enterprise type, age, size and income all had weak influences on GSCM practices. Enterprise type had a significant negative influence on internal improvement ($b = -.065$). As a result, we can speculate that the more an enterprise is privatized, the less it is inclined to practice internal improvement. In addition, enterprise age had a significant positive influence on internal improvement ($b = .076$). We can conclude that the longer an enterprise has existed, the more inclined it is to practice internal improvement. Income has a positive effect on external improvement ($b = .061$), meaning that companies with greater revenue tend to practice more external improvement.

The results in **Table A6** indicate that external improvement practice reduced positive economic performance ($b = -.408$) and internal improvement practice significantly enhanced enterprises' performance ($b = .689$, .507, .307, .364). Ecology practice improved environmental, positive economic and operational performances ($b = .204$, .590, .447). Regarding the economic effect, GSCM practices had a greater impact on positive economic performance than negative economic performance. Thus, GSCM's implementation benefitted economic performance, and enhanced the enterprise's operational performance. As for the moderating variable, the interaction term of internal improvement practice and QR had a significant negative effect on negative economic performance ($b = -.411$). The interaction effects are depicted by the graph in **Figure A3**. The figure shows that the quick response technology suppressed the positive effect of the enterprise's internal improvement practice on the negative economic performance.

In addition, enterprise type, size, income, and age had weak influences on enterprise performance. Enterprise size had a positive influence on both environmental performance ($b = .068$) and positive economic performance ($b = .069$). The firm's age had a negative effect on negative economic performance ($b = -.102$). The relationships between other variables, however, were not significant. Finally, we summarize the main results of the hypotheses in **Table A7**.

As **Tables A5 and A7** demonstrate, for GSCM pressures, the market factor is the main pressure, which is inconsistent with Hypotheses 1. The reason may be as follows. First, the Chinese government has become increasingly strict about environmental preservation and introduced a series of related policies and regulations. Second, there are more state-owned enterprises than any other type of company, and they face more pressure from the government. Third, Chinese consumers are more environmentally conscious and domestic consumers form the major market segment.

The cost factor had no significant impact on GSCM practices. This result is inconsistent with our hypothesis, possibly because, in China, implementing GSCM practices may increase the market demand even though enterprises are sensitive to the cost, thus benefits from GSCM practices may offset the implementing cost. Meanwhile, the costs mentioned in the questionnaire are directly related to environmental protection. Enterprises considering these costs have already had a certain degree of practice in environmental protection, whereas for other aspects of practice, they are not sensitive to these costs. Thus, Hypotheses 2a and 2c are supported, while Hypothesis 2b is not supported.

For GSCM practices, the results rejected Hypothesis 3a, supported Hypothesis 3b, and did not fully support Hypothesis 3c. Note that the external improvement factor had a significant negative influence on positive economic performance, while internal improvement practice could significantly improve enterprises' performance. First, because external improvement practice focuses on the environmental requirements for suppliers (refer to **Table A3**), the implementation of these measures would have no significant effects on economic or operational performance. Considering that the enterprises in this survey are mainly production companies, environmental improvement performance is mainly reflected in the production process, and its internal practice accounts for the main factor. In addition, the companies have less external environmental protection practices (mean value = 3.19). Therefore, the external practice had no significant impact on environmental performance, while internal improvement did have a significant impact. Besides, the implementation of internal environmental practices improved corporate management and employee productivity; thus, the positive effect was bigger than the negative effect and economic performance was enhanced. The ecology practices significantly improved environmental, economic and operational performance. This is because ecology practices mainly involve recycling and consumption reduction of products and materials, which do not have a direct effect on negative economic performance.

For GSCM performance, Hypotheses 4a, 4b, and 4d were not supported by the results, while Hypothesis 4c was partly supported. The results suggested that QR had moderation effects between internal improvement practice and negative economic performance. We argue that enterprises implementing internal improvement practices would incur increased administrative costs and fixed costs in pursuit of GSCM. However, implementing QR technology would also reduce unnecessary waste due to the implementation of internal improvement practices. It is notable that the existence of QR technology does not necessarily lead to good economic performance.

6 | REAL CASE STUDIES

Next we present two real case studies, performed to examine our hypotheses and ensure the robustness of our results, that is, adopting a multi-methodological approach (Choi, Cheng, & Zhao, 2016). Specifically, we conducted interviews to investigate the innovative measures of GSCM as well as the role played by quick response (QR) in China. Referring to firms' CSR and annual environmental monitoring reports, we chose two leading Chinese companies: Huawei (Huawei Technologies Co., Ltd.) and BBAC (Beijing Benz Automotive Co., Ltd.), with the intention of learning more about GSCM implementation, and providing practical evidence of the hypotheses verified in the previous section. It is important to observe that these two companies are dedicated to building a mechanism for GSCM.

6.1 | Interview design

We conducted interviews to identify each company's GSCM pressures, practices and performance. Nine managers from each firm were selected to participate in the interviews, coming from their respective production, marketing and sales departments. We referred to the studies of Chan et al. (2016) and Senot, Chandrasekaran, and Ward (2016) and used structured interviews, newsletters and project meeting reports to collect the data and ensure the findings' reliability and validity. The purpose of the interviews was to identify

GSCM's importance and examine real-world scenarios of GSCM-3P. We adopted interview questions as follows: What environmental pressures do firms face in the supply chain management process? Are there some environmental practices implemented in the companies' supply chain management? How are these practices implemented and what are the impacts of these practices on enterprise performance? Do the firms benefit from GSCM or not by means of innovative tools, for example, quick response (QR)? After answering the interview questions, the interviewees were invited to elaborate on their firms' specific GSCM pressures, practices and performance items, as identified in the literature, and reflect the relationships among GSCM pressures, practices and performance. The interview results helped us to verify our derived results and the relationships among GSCM pressures, practices and performance, as well as the moderating effect of QR. **Table A8** provides a summary of the managerial interviewees and the interview method used for both companies.

6.2 | Case study 1: Huawei

Huawei Technologies Co., Ltd. (Huawei),[5] the largest telecommunications equipment manufacturer in the world, reached a profit of 92.549 billion in 2017. As an adopter of GSCM, Huawei pays more and more attention to sustainable development and commits to deliver innovative technologies to make their supply chain greener. According to the corporate social responsibility (CSR) report in 2017,[6] Huawei has a high score in the CSR development index. Huawei integrates green ideas into the whole product development process and optimizes its utilization of resources in a sustainable way. In addition to external improvement activities, Huawei also pays full attention to internal improvement activities, such as energy utilization in facilities and the reduction of emissions. Moreover, Huawei strictly requires that their products must meet rules and requirements related to the environment. Based on international standards including ISO 14001 and OHSAS 18001, Huawei has established a sustainability management system in order to systematically plan, implement, monitor and improve their business performance.

We interviewed nine Huawei managers, from their respective production, marketing, and sales departments. Consistent with our theorization, the respondents expressed the need to implement GSCM in response to environmental pressures. Moreover, in the actual production plants, GSCM has been applied to each link of the firms' supply chain. The managers indicated that the firm was confronted with various pressures, which promoted the implementation of GSCM practices. Furthermore, the managers emphasized the importance of stakeholders and market pressure in implementing GSCM practices. In particular, it is well-known that Huawei implements employee stock-ownership plans. The managers who were interviewed thought that the market and export pressures had positive effects on the implementation of Huawei's GSCM practices. They listed the factors affecting their GSCM practices, including organizational involvement, alternative material research, external improvement, product recycling ecology, supplier management, and logistics, all of which, except for logistics, are classified as internal and external improvement in our research. The managers shared their experiences of incorporating GSCM into product design, raw material optimization, product recycling and waste recovery, which were considered important in developing the relationship between GSCM practices and firms' performance. Consistent with our verified results, they also indicated that internal improvement played a more significant role in the enterprise's GSCM practices. External improvement practices did not meet their expectations and had little positive effect on Huawei's environmental performance. This suggests that the enterprise should seek more appropriate ways to improve the impact of their external improvement practice on environmental performance. Ecology had a significant impact on their GSCM performances, especially the economic and operational performances.

To cope with environmental uncertainty, the managers also suggested the adoption of quick response (QR) technology, of which the effect on GSCM had not been investigated in the previous literature. They believed that the effect of environmental uncertainty was high, especially on firms' economic and operational performances, but they all indicated that in practice quick response had no significant effect on the enterprise's performances. Interestingly, QR technology had a negative effect on the relationship between the enterprise's internal improvement practice and negative economic performance. That is, adopting quick response technology was advantageous for the enterprise in this respect. In summary, all of the managers pointed out that the GSCM pressures, practices and performance derived from the literature were largely consistent with their company's experiences. Huawei continuously acts as an industrial benchmark for green and sustainable operations, energy sustainability and reduced emissions in China. However, green companies will need to follow a uniform criterion standard and an integrated evaluation system in the future.

6.3 | Case study 2: BBAC

Beijing Benz Automotive Co., Ltd. (BBAC)[7] is a leading automotive manufacturing enterprise with an annual production of 300,000 units. Following the concept of green manufacturing and sustainable development, BBAC always makes efforts to realize "green products, green production, green consumption, and green markets" and carries out environmental monitoring in each process of their automobile production. In terms of CSR, BBAC attaches great importance to protecting the ecological environment, saving social resources, and supporting public welfare.

At BBAC, we also interviewed nine managers from their respective production, marketing, and sales departments. They asserted that all of their current companies, including the suppliers, were confronted with many pressures to implement GSCM practices. In particular, their automobile production department has experienced various pressures, such as population growth, scientific and technological pressures and government policy pressure. Moreover, in the context of the auto industry in China, the government as a law-maker puts great pressure on companies' GSCM practices. In order to meet government policies and regulations, BBAC exerts strict control over component suppliers, sewage discharge and waste gas emissions during the production process, as well as safety stock and product precautions. At each stage, BBAC has established environmental management documents for each supplier and audited its environmental credentials by tracking suppliers' manufacturing processes. Although BBAC does not manufacture all of the Mercedes-branded autos, some Mercedes offerings are exported by BBAC. As the exportation of parts and components for BBAC increases, the pressure to implement GSCM also increases. The managers pointed out that the domestic and international market pressures for components were not negligible, and argued that "market" is always a factor in deciding whether or not to adopt a certain green practice.

Next, the respondents answered how the above-mentioned pressures affected BBAC's GSCM practices. They all agreed that population growth, government policy, and supplier environmental audit pressures had a positive effect on their GSCM practices. Note that population growth, government policy, and supplier pressures are largely aligned with market pressure, as revealed in our literature review. In addition, we find that "greater export and market pressures on the environment" imply a "greater positive effect" on BBAC's ecological practices in GSCM. After that, the respondents gave their opinions on how GSCM practices affected BBAC's performance. Similar to the responses from Huawei's managers, BBAC's managers emphasized that internal improvement and ecology practices had significant effects on the enterprise's environmental performance, while external improvement had less effect on their environmental performance. Furthermore, the increasing number of GSCM practices containing internal improvement and QR were advantageous to BBAC's economic performance. Finally, in answering whether or not the company had adopted quick response (QR), they indicated that BBAC applied QR to both their auto manufacturing process and their GSCM practices. They found that QR played a negative role in moderating the relationship between the firm's internal enhancement practice and their negative economic performance; in other words, implementing QR technology reduced the GSCM cost and helped improve BBAC's economic performance. All of the feedback indicated that the relationships among GSCM pressures, practices, and the enterprise's performance were in line with our statistical analysis findings.

7 | DISCUSSION AND MANAGERIAL IMPLICATIONS

7.1 | Discussion

Based on the descriptive and SEM analyses, we can conclude that Chinese enterprises have experienced GSCM to a certain extent, given that all of the mean values exceeded 3.0 (On the five-point scale, an item cannot be ignored if its value exceeds 3.0, and is considered important if its value reaches more than 4.0.) In some industries, such as the petroleum and pharmaceutical industries, several items exceeded or nearly exceeded 4.0. Different industries confronted various pressures for practicing GSCM. Among all of these pressures, market pressure was the most prominent because its degree of pressure (mean) and its impact on GSCM practices were greater than those of the other two pressures (cost and export).

Table A3 shows that market pressure originates from aspects of policy, customers, and suppliers. The average scores indicate that policy pressure is more prominent than the others. This encourages Chinese enterprises to practice GSCM because of deteriorating resources, environmental problems, and the pressures of changing economic structures brought about by demographic changes. This conclusion confirms what Zhu and Sarkis (2004) proposed in their research. Moreover, although the export factor was not the main pressure, it had a significant and positive impact on GSCM practices, especially in export and ecology. This can be attributed to fierce international competition and increasing environmental awareness in the international market, which Chinese enterprises must cope with. China has to strengthen sustainable development and speed up economic transition to maintain its competitiveness in the export trade.

Although market pressure had a significant impact on GSCM practices, its promoting effect on ecology was less than that on the other two practice factors. The reason may be that market pressure (including policy, customers, and suppliers) directly affects the management of enterprises and indirectly promotes ecology. In addition, cost pressure influences GSCM practices of enterprises to a certain extent, but not significantly. Interestingly, cost pressure is positively associated with ecology, which is contradictory to our hypothesis. This may be because a higher cost pressure on enterprises would yield a greater economic benefit from the increase of ecologically sound practices.

Table A6 indicates that the internal improvement and ecology practices significantly promote environmental performance, whereas external improvement contributes little to the enterprises' performance. From **Table A3**, we can see that internal practices include measures of protecting the environment directly, such as training for workers on sustainability issues, achievement of ISO 14001 certification, and proper disposal of industrial waste. Undoubtedly, all of these measures will increase enterprises' financial costs. Meanwhile, external practice does not affect the enterprises' performance directly since it mainly includes cooperation with and requirements for suppliers. Considering that internal improvement practice can promote company management, enhance staff efficiency, and reduce material waste, it has a positive effect on the enterprise's economic performance. Moreover, considering GSCM practices, the ecology practice has been performed less by enterprises, but it has a significantly positive effect on enterprise performance, especially on positive economic and operational performances. We present the relationship framework in **Figure A4**, where the arrow indicates the direct effect.

Regarding the moderating variable, Table **A6** shows that QR has a significantly negative impact on the relationship between internal improvement practice and negative economic performance. This means that implementing QR technology will not help to promote economic performance directly. However, it will suppress the negative effect that internal improvement may have on business benefit. For instance, Dong et al. (2001) uncover that the costs of suppliers and buyers may be lower under QR. Moreover, as indicated by Mia (2000) and Callen et al. (2000), using QR technology can lead to a higher productivity but a lower variable cost. They also suggest that QR technology does not necessarily generate more profit for enterprises. **Table A6** indicates that QR has an insignificant relationship with both operational and environmental performance, which is different from the findings of Choi and Cai (2018). This result may be attributed to the gap between the goal of QR technology and its actual performance when implemented among Chinese enterprises.

As two leading manufacturing countries, China and Japan represent two different production mechanisms (with different stages of development) in Asia. A comparison of GSCM practices between Chinese and Japanese enterprises is shown in **Table A9**. Given that Japan lacks abundant natural resources, it pays more attention to protecting the environment and efficiently utilizing its resources. **Table A9** indicates that Japan is more advanced than China in terms of internal and external improvement. In detail, the mean values of internal improvement in Japan exceed 4.5, whereas in China, they are below 4.0. Moreover, Japan attaches more attention to the disposal of toxic materials and waste recovery. In terms of various innovative GSCM measures, such as "cross-functional cooperation for environmental improvements," "providing design specification to suppliers that include environmental requirements for purchased items," and "design of products to avoid or reduce the use of hazardous products," Japan tends to perform much better than China. However, in areas such as "design of products for reduced consumption of material/energy," and "design of products for reuse, recycling, and recovery of material and component parts," China seems to perform better than Japan even though neither country excels 4.0. These interesting observations uncover that developing countries like China, as well as developed countries like Japan, still have plenty of opportunities to improve their GSCM measures.

7.2 | Managerial implications

Based on the insights discussed above, we now propose the following implications which can improve GSCM practices.

7.2.1 | Implications for governments

Governments should strengthen supervision and take leading roles in promoting GSCM practices among enterprises. Based on the above analysis, the Chinese government's policy has, thus far, been effective in restraining enterprises' behaviors. Further strengthening supervision would undoubtedly be an efficient way to force enterprises to eradicate activities that have negative influences on the environment. However, many Chinese enterprises implement superficial measures in the case of government supervision, and then simply return to old ways that harm the environment. Thus, the Chinese government should consider implementing more systematic and long-term measures (e.g., making laws, outlining rules, and setting policies) to supervise the operational activities carried out by enterprises. Moreover, innovative incentives should be granted to encourage enterprises to behave better, and punishments should be implemented to prevent them from performing worse, in terms of environmental protection.

According to the results of Hypotheses 1, 2a, 2b, and 2c, Chinese enterprises are faced with many pressures, among which market pressures are the most important. The results in **Table A5** show that the market factor had a significant, positive influence on GSCM practices. Moreover, the export factor also had a positive influence on GSCM practices.

Therefore, one feasible way for the government to enhance environmental protection is to enhance the role of market pressures. The government should take targeted measures aimed at different industries, help enterprises innovatively transform their operational modes, and promote better environmental performance with technological innovation. Meanwhile, the government can also take some novel and creative measures that influence the market (e.g., advocating for environmentally-friendly consumption, educating the public and promoting awareness about environmental protection). Another feasible way to enhance environmental protection is to promote commodity exports, so that enterprises, in turn, will be incentivized to practice GSCM.

China is at a key stage of its economic transition. However, the increasingly severe situation of demographic structural change and environmental problems puts great pressure on the Chinese government. Promoting economic structure transformation and encouraging the development of emerging industries are also both effective ways to improve environmental protection. Meanwhile, the government should introduce new technologies, encourage business innovation, and create more opportunities for enterprises to learn new management methods and apply new technologies, all of which can effectively benefit the environment.

7.2.2 | Suggestions for enterprises

According to the results of Hypotheses 3a, 3b, and 3c in **Table A7**, internal improvement can promote enterprises' environmental protection performance. Moreover, the implementation of internal practice promotes the economic and operational performance by increasing management efficiency. However, the external practice suppresses positive economic performance, which suggests a need for more effective cooperation. In the long term, enterprise managers should devote themselves to implementing GSCM practices. Particularly, we note that the ecology factor has a significant impact on environmental and business performance. Thus, it is important for enterprises to strengthen their ecology practices. Enterprises should also make improvements to many other aspects, such as their management mode, efficiency, and use of technology. Moreover, Chinese enterprises should strengthen their ecology practices and adopt innovative measures, such as enhancing resource recycling and developing creative eco-design. These not only help to improve business performance, but they also make contributions to resource conservation and environmental protection. In addition, implementing effective GSCM practices can help enterprises achieve their goals of environmental protection. For example, establishing sustainable strategic partnerships is key for promoting environmental and economic performance. Compared with enterprises in developed countries, Chinese enterprises may be lagging far behind in these respects.

According to the results of Hypotheses 4a, 4b, 4c and 4d in **Table A7**, we know that QR technology had a significant negative moderation effect on the relationship between internal improvement practice and negative economic performance, and a non-significant impact on other GSCM performance. In other words, implementing QR technology will simply suppress the positive effect that internal improvement practice has on enterprises' negative economic performance, but it does not necessarily benefit economic performance. However, with the soaring development of electronic commerce, it is crucial for enterprises to be able to respond to consumers' demand variety in time. Thus, considering GSCM performance, enterprises should strike a balance by using QR technology as a tool for strengthening their flexibility and responsiveness.

8 | CONCLUSION AND FUTURE RESEARCH

8.1 | Summary of findings

This paper reports empirical research among Chinese enterprises by using an industrial questionnaire to investigate relationships among GSCM pressures, practices, and performance. We have considered QR, a technology-driven industrial measure, as the moderating variable and examined whether or not it has an impact on the relationship between GSCM performance and GSCM practices. Based on the analysis, we have tested the hypotheses and obtained the following results.

First, Chinese enterprises bear different kinds of pressures when implementing GSCM, among which, market pressure is the most prominent. This result has been confirmed by Hypothesis 1, which is in line with the finding of Zhu et al. (2005). This finding implies that enterprises should improve their production pattern and realize industrial innovation, while the staff members of enterprises, especially in the management hierarchy, should enhance their awareness of environmental protection to the strategic level and actively promote environmental protection policies.

Second, among the GSCM pressures, market and export pressures have significant impacts on GSCM practices, whereas the impact of cost pressure is not significant, which partially confirms Hypothesis 2. As summarized in **Tables A3 and A7**, policy pressure is the greatest pressure that Chinese enterprises are confronted with. Therefore, the Chinese government can develop relevant policies to guide and provide proper incentives to improve enterprises' GSCM practices.

Third, for GSCM practices, internal improvement practices have significant impacts on enterprises' performance, while external improvement practice only negatively affects enterprises' positive economic performance. In addition, ecology practice has a significant impact on the positive economic, environmental, and operational performances. All of these partially confirm Hypothesis 3. This finding indicates that enterprises should strengthen ecology practices and adopt innovative measures in external practices, such as enhancing resource recycling and developing creative ecodesign.

Fourth, QR suppresses the positive relationship between negative economic performance and internal improvement practice. However, it does not significantly affect the relationships between GSCM practices and other performances. This partially confirms Hypothesis 4, consistent with Zhu and Sarkis (2004). Thus, the enterprises should use QR technology moderately to enhance enterprise's economic performance, although it is still crucial for enterprises to meet consumers' personalized demand and maintain market competitiveness.

Finally, the influence of GSCM practices on negative economic performance is lower than on positive economic performance. This result, obtained from SEM, is inconsistent with the classic study by Bragdon and Marlin (1972). It also implies that the benefit from GSCM practices has outweighed the cost, and Chinese enterprises have made great improvements in supply chain management practices and technological applications.

Additionally, we have conducted real case studies by reporting interview results from two companies, namely Huawei and BBAC. These case studies support our statistical analysis findings.

Based on the above analysis, we have also provided some theoretical and practical implications of our findings, which can help governments and companies to draft effective policies (see Section 7.2).

8.2 | Major contributions

This paper contributes in several ways. First, we consider the market, export and cost factors when examining GSCM pressures and practices in Chinese enterprises. Our results interestingly reveal that Chinese enterprises do not regard cost pressure as an obstacle in implementing GSCM practices, which is a sharp contrast to the prevailing belief in the literature (e.g., see Lee & Klassen, 2008). We find that the market factor is the main pressure which affects the practice of GSCM by Chinese enterprises. This important finding arises due to different cultures, governing styles, and types of ownership of among Chinese enterprises. Second, our study provides evidence for various controversial issues, such as the moderating role of QR, and positive or negative effects of innovative GSCM practices on enterprise performance. We show that QR has a "negative moderating effect" on the relationship between internal improvement practice and enterprises' negative economic performance. Third, in GSCM, this paper proposes a positive relationship between ecological and economic performance as well as operational performance. Finally, based on comparison with the situation outside of China, we have made some innovative and practical suggestions to governments and enterprises so that our findings can potentially enhance industrial practices.

8.3 | Limitations and future studies

This paper, nevertheless, has certain limitations. First, the range of the data source is not so wide, and the industries we studied are centralized. This may have some influence on the validity of the data. Future research should take samples from a larger group. Second, owing to a lack of sufficient data, our analysis does not cover a detailed study of individual industries. Future research can hence be extended to explore the GSCM practices of enterprises in individual industries, by conducting a comprehensive analysis of a larger amount of data from different companies.

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ENDNOTES

[1] Note that now the name Ministry of Environmental Protection of China is changed to be Ministry of Ecology and Environment of China.

[2] Drazin and Schoonhovenm (1996) define innovation as the development and implementation of ideas for improved processes, products, or procedures.

[3] http://www.guancha.cn/economy/2016_01_13_347893.shtml.

[4] The firm's "age" indicates how long the enterprise has existed.

[5] For Huawei Technologies Co., Ltd., see http://www.huawei.com.cn.

[6] Research report on corporate social responsibility of China (2017).

[7] For the Beijing Benz Automotive Co., Ltd., see http://www.bbac.com.cn.

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APPENDIX A

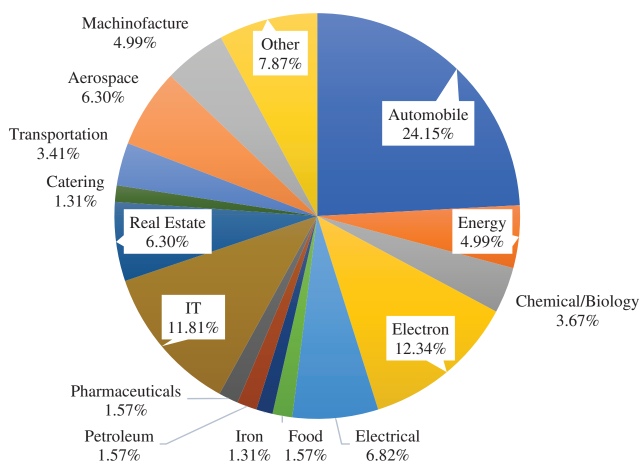

FIGURE A1 Industry distribution of respondent enterprises [Color figure can be viewed at wileyonlinelibrary.com]

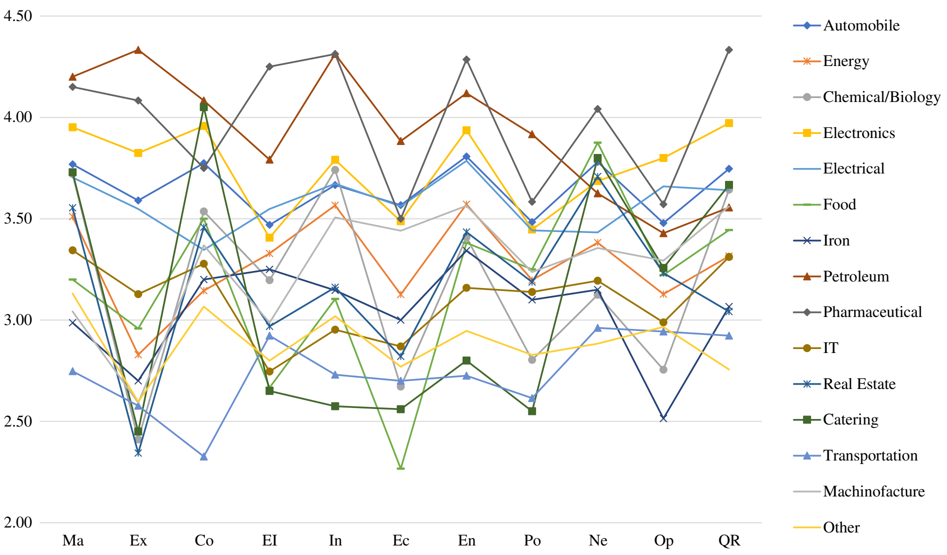

FIGURE A2 Average values of different factors in different industries [Color figure can be viewed at wileyonlinelibrary.com]

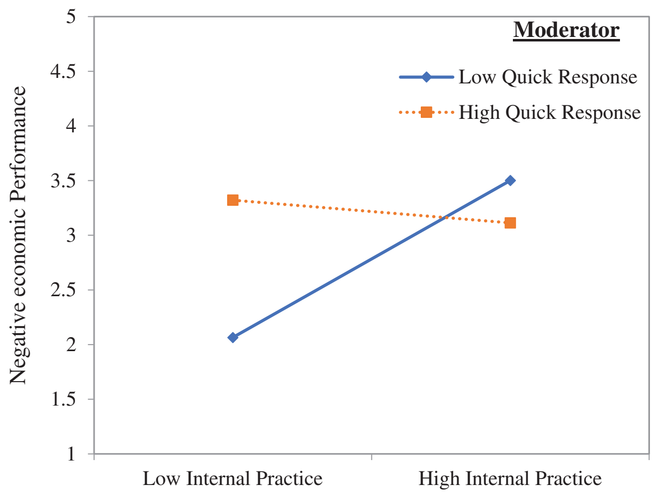

FIGURE A3 Interaction effect of quick response and internal improvement practice [Color figure can be viewed at wileyonlinelibrary.com]

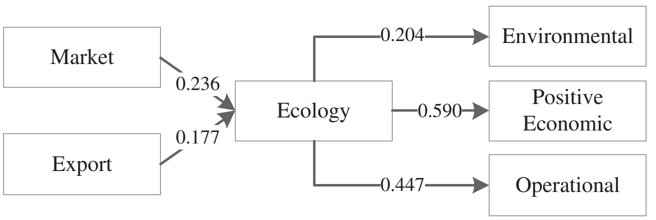

FIGURE A4 Relationships among GSCM pressures, ecology practices, and performance

TABLE A1 Five-point Likert scales

	Scale description		
Point	Part 2	Part 3	Part 4
1	Not important at all	Not considering it	Not at all
2	Not important	Planning to consider it	A little bit
3	Not thinking about it	Considering it	To some degree
4	Important	Initiating implementation	Relatively significant
5	Extremely important	Implementing successfully	Significant

TABLE A2 Distribution of respondent enterprises

Variable	Sample size	Percentage	Variable	Sample size	Percentage
Type			Income (million)		
State-owned	150	39.27%	<10	27	7.20%
Joint venture	35	9.16%	10–50	53	14.13%
Foreign	71	18.59%	50–100	38	10.13%
Private	120	31.41%	100–500	58	15.47%
Others	6	1.57%	500–1,000	45	12.00%
Total	382	100%	>1,000	154	41.07%
			Total	375	100%
Age (year)					
<1	24	6.32%			
1–3	86	22.63%	Job position of respondent		
3–5	57	15.00%	General manager	2	.53%
5–10	83	21.84%	Vice manager	17	4.52%
>10	130	34.21%	Department manager	77	20.48%
Total	380	100%	Logistics manager	96	25.53%
			Production manager	32	8.51%
Size (number of employees)			Purchasing manager	105	27.93%
<100	38	9.95%	Sales manager	27	7.18%
100–500	78	20.42%	Others	20	5.32%
500–1,000	67	17.54%	Total	376	100%
1,000–3,000	81	21.20%			
3,000–8,000	36	9.42%			
>8,000	82	21.47%			
Total	382	100%			

TABLE A3 Descriptive statistics of the samples

Sections	Items		N	Mean	*SD*
GSCM pressure	Ma	Market pressure		3.55	
	Ma1	Governmental environmental regulations	383	3.87	1.209
	Ma2	Governmental resource saving and conservation regulations	382	3.70	1.184
	Ma3	Chinese consumers' environmental awareness	381	3.30	1.235
	Ma4	Establishing company's green image	381	3.62	1.128
	Ma5	The news media follows our industry closely	382	3.62	1.079
	Ma6	The competitors' environmental strategy	382	3.51	1.183
	Ma7	Suppliers' advances in developing environmentally friendly goods	382	3.50	1.172
	Ma8	Environmental partnership with suppliers	383	3.46	1.075
	Ma9	Supplier's advances in providing environmentally friendly packages	382	3.41	1.053
	Ma10	Making sure that suppliers will remain in business (business continuity)	382	3.47	1.071
	Ex	Export pressure		3.16	
	Ex1	Export order magnitude	381	3.03	1.441
	Ex2	Foreign consumers' consumption habits	379	3.03	1.440
	Ex3	Export countries' environmental regulations	381	3.27	1.529
	Ex4	Internal multinational policies (subsidiaries or divisions of a multinational firm)	380	3.32	1.289
	Co	Cost pressure		3.49	
	Co1	Cost for disposal of industrial waste	383	3.54	1.129
	Co2	Cost for disposal of hazardous materials	383	3.53	1.215
	Co3	Cost of environmentally friendly goods	380	3.47	1.107
	Co4	Cost of environmentally friendly packages	378	3.43	1.122
GSCM practices	EI	External improvement		3.19	
	EI1	Providing design specification to suppliers that include environmental requirements for purchased items	383	3.18	1.094
	EI2	Cooperation with suppliers for environmental objectives	382	3.14	1.095
	EI3	Environmental audit for suppliers' inner management	383	3.17	1.181
	EI4	Suppliers' ISO14000 certification	380	3.25	1.210
	In	Internal improvement		3.43	
	In1	Total quality environmental management	380	3.76	1.053
	In2	Special training for workers on environmental issues	383	3.40	1.163
	In3	ISO 14000 certification	383	3.47	1.292
	In4	Disposal the industrial waste before discharge	383	3.54	1.221
	In5	Environmental management systems exist	383	3.40	1.215
	In6	Eco-labeling of products	381	3.14	1.152
	In7	Support for GSCM from managers	379	3.55	1.076
	In8	Cross-functional cooperation for environmental improvements	382	3.19	1.131
	Ec	Ecology improvement		3.21	
	Ec1	Recovery of the products	383	3.25	1.192
	Ec2	Resource recycling	383	3.30	1.198

(Continues)

TABLE A3 (Continued)

Sections	Items		N	Mean	*SD*
	Ec3	Recovery of the packages	381	3.10	
	Ec4	Investment recovery (sale) of excess inventories/materials	382	3.11	1.217
	Ec5	Sale of scrap and used materials	382	2.99	1.216
	Ec6	Sale of excess capital equipment	383	3.09	1.205
	Ec7	Design of products for reduced consumption of material/ energy	383	3.37	1.150
	Ec8	Design of products for reuse, recycling, and recovery of material and component parts	383	3.28	1.171
	Ec9	Design of products to avoid or reduce the use of hazardous materials in products	383	3.33	1.120
	Ec10	Design of processes for minimization of waste	375	3.30	1.117
Performance	En	Environmental performance		3.53	
	En1	Reduction of air emission	383	3.43	1.173
	En2	Reduction of waste water	383	3.48	1.177
	En3	Reduction of solid wastes	383	3.59	1.134
	En4	Decrease of consumption for hazardous/harmful/toxic materials	382	3.60	1.120
	En5	Decrease of frequency for environmental accidents	383	3.67	1.141
	En6	Improve a company's environmental situation	383	3.66	1.073
	En7	Decrease of fine for environmental accidents	383	3.31	1.232
	Po	Positive economic performance		3.26	
	Po1	Decrease of cost for materials purchasing	383	3.29	1.152
	Po2	Decrease of cost for energy consumption	382	3.33	1.137
	Po3	Decrease of fee for waste treatment	383	3.28	1.134
	Po4	Decrease of fee for waste discharge	383	3.15	1.119
	Ne	Negative economic performance		3.47	
	Ne1	Increase of investment	382	3.55	.992
	Ne2	Increase of operational cost	383	3.52	.973
	Ne3	Increase of training cost	383	3.34	1.013
	Ne4	Increase of cost for purchasing environmentally friendly material	382	3.45	1.075
	Op	Operational performance		3.31	
	Op1	Increase amount of goods delivered on time	382	3.30	1.153
	Op2	Decrease of response time	380	3.29	1.126
	Op3	Decrease inventory levels	382	3.20	1.178
	Op4	Decrease scrap rate	383	3.27	1.216
	Op5	Promote product quality	383	3.50	1.137
	Op6	Improved capacity utilization	383	3.45	1.145
	Op7	Decrease of income to dispose the inventory	383	3.17	1.106
Moderator	QR	Quick responses		3.49	
	QR1	Adopting just-in-time logistics system	380	3.54	1.093
	QR2	Adopting TPL (third-party logistics)	382	3.50	1.156
	QR3	Quick response production mode	382	3.43	1.098
		Total	383		

TABLE A4 Correlations among GSCM Pressures, practices, and performance

	Ma	Ex	Co	EI	In	Ec	En	Po	Ne	Op	QR
Pressures											
Ma	.901										
Ex	.514	.883									
Co	.580	.602	.843								
Practices											
EI	.414	.516	.373	.813							
In	.339	.372	.327	.459	.904						
Ec	.327	.487	.377	.543	.352	.915					
Performance											
En	.409	.472	.431	.525	.389	.442	.923				
Po	.263	.438	.360	.330	.279	.400	.593	.878			
Ne	.301	.306	.335	.358	.254	.294	.422	.332	.805		
Op	.294	.321	.277	.363	.516	.390	.553	.595	.356	.917	
Moderator											
QR	.392	.509	.380	.516	.342	.403	.370	.297	.324	.339	.720
Mean	3.55	3.16	3.49	3.43	3.19	3.21	3.53	3.26	3.47	3.31	3.49
SD	.84	1.22	.99	.89	.94	.91	.95	.99	.83	.95	.89

Note: Sample size = 383. Values on the diagonal are estimates of scale reliability. $p < .01$ for all correlations.

TABLE A5 SEM for GSCM pressures and practices

	SEM 1		
	EI	In	Ec
Control variables			
Type	−.025	−.065**	−.040
Firm age	.052	.076*	.011
Firm size	.031	.020	.043
Income	.061*	.008	.016
Independent variables			
Ma	.654***	.522***	.236*
Ex	.179***	.090**	.177***
Co	−.135	−.048	.154

*$p < .05$; **$p < .01$; ***$p < .001$.

TABLE A6 SEM for GSCM practices and performance

	SEM 2 (main effect)				SEM 3 (interaction effect) model 4			
	En	Po	Ne	Op	En	Po	Ne	Op
Control variables								
Type	.009	−.010	−.003	−.042	.009	−.003	.008	−.040
Age	−.044	.000	−.102*	−.067	−.049	−.001	−.145**	−.073
Size	.068*	.069*	.021	.015	.076*	.078*	.041	.020
Income	−.003	.047	.002	−.056	−.005	.046	−.001	−.064
Independent variables								
EI	.149	−.408**	.094	−.150	.251	−.390*	.173	−.133
In	.689***	.507**	.307*	.364*	.502**	.334*	.204*	.208
Ec	.204*	.590***	.073	.447***	.178	.565***	.069	.452***
QR	−.064	.132	.217*	.165	−.140	.097	.228*	.169
Moderating effects								
EI × QR					.017	−.036	.117	.007
In × QR					−.064	−.098	−.411*	−.195
Ec × QR					.036	.125	.225	.174

$^*p < .05$; $^{**}p < .01$; $^{***}p < .001$.

TABLE A7 Summary of hypothesis testing results

Hypothesis		Effect	Conclusion	Remark
Hypothesis 1	Export is the main GSCM pressure		×	It is market
Hypothesis 2a	Market → external improvement	+	√	
	Market → internal improvement	+	√	
	Market → ecology	+	√	
Hypothesis 2b	Cost → external improvement	−	×	n
	Cost → internal improvement	−	×	n
	Cost → ecology	−	×	n
Hypothesis 2c	Export → external improvement	+	√	
	Export → internal improvement	+	√	
	Export → ecology	+	√	
Hypothesis 3a	External improvement → environmental	+	×	n
	External improvement → positive economic	+	×	−
	External improvement → negative economic	+	×	n
	External improvement → operational	+	×	n
Hypothesis 3b	Internal improvement → environmental	+	√	
	Internal improvement → positive economic	+	√	
	Internal improvement → negative economic	+	√	
	Internal improvement → operational	+	√	
Hypothesis 3c	Ecology → environmental	+	√	
	Ecology → positive economic	+	√	
	Ecology → negative economic	+	×	n
	Ecology → operational	+	√	

(Continues)

TABLE A7 (Continued)

Hypothesis		Effect	Conclusion	Remark
Hypothesis 4a	Quick response × external improvement → environmental	−	×	n
	Quick response × internal improvement → environmental	−	×	n
	Quick response × ecology → environmental	−	×	n
Hypothesis 4b	Quick response × external improvement → positive economic	+	×	n
	Quick response × internal improvement → positive economic	+	×	n
	Quick response × ecology → positive economic	+	×	n
Hypothesis 4c	Quick response × external improvement → negative economic	−	×	n
	Quick response × internal improvement → negative economic	−	√	
	Quick response × ecology → negative economic	−	×	n
Hypothesis 4d	Quick response × external improvement → operational	+	×	n
	Quick response × internal improvement → operational	+	×	n
	Quick response × ecology → operational	+	×	n

Note: positive effect (+), negative effect (−), support (√), reject (×), non-significant correlation (*n*).

TABLE A8 Managerial interviewees and interview method

	Huawei		BBAC	
Functional department	Numbers of managers	Interview method	Numbers of managers	Interview method
Production department	3	Phone	3	In-person
Market department	3	In-person	3	In-person
Sales department	3	Phone	3	In-person

TABLE A9 Comparison of key GSCM practices of Chinese and Japanese enterprises

GSCM practices	Mean in China	Mean in Japan[a]
EI		
Providing design specification to suppliers that include environmental requirements for purchased items	3.18	3.33
Cooperation with suppliers for environmental objectives	3.14	3.71
Environmental audit for suppliers' inner management	3.17	3.29
Suppliers' ISO14000 certification	3.25	4.00
In		
Total quality environmental management	3.76	4.78
ISO 14000 certification	3.47	4.89
Environmental management systems exist	3.40	4.67
Support for GSCM from managers	3.55	4.89
Cross-functional cooperation for environmental improvements	3.19	4.56
Ec		
Investment recovery (sale) of excess inventories/materials	3.11	3.00
Sale of scrap and used materials	2.99	4.00
Sale of excess capital equipment	3.09	2.67
Design of products for reduced consumption of material/energy	3.37	3.33
Design of products for reuse, recycling, and recovery of material and component parts	3.28	2.80
Design of products to avoid or reduce the use of hazardous of products	3.33	4.17

[a]Data from Zhu et al. (2010).

APPENDIX B

TABLE B1 Corrected Correlations by Correlational Marker Technique

		Ma	Ex	Co		EI	In	Ec	QR
Correlation with maker		0.061	0.140	0.061		0.115	0.082	0.092	0.067
r=0.036	**EI**	0.388 (0.449)	0.492 (0.579)	0.346 (0.415)	**En**	0.502 (0.579)	0.357 (0.385)	0.419 (0.451)	0.346 (0.424)
	In	0.295 (0.319)	0.326 (0.359)	0.284 (0.320)	**Po**	0.305 (0.357)	0.243 (0.264)	0.378 (0.416)	0.263 (0.330)
	Ec	0.295 (0.317)	0.461 (0.509)	0.346 (0.390)	**Ne**	0.326 (0.400)	0.222 (0.252)	0.263 (0.300)	0.295 (0.387)
					Op	0.336 (0.385)	0.492 (0.536)	0.367 (0.395)	0.305 (0.374)
α=0.25 r'=0.095	**EI**	0.348 (0.391)	0.459 (0.535)	0.304 (0.354)	**En**	0.470 (0.538)	0.315 (0.325)	0.381 (0.397)	0.304 (0.369)
	In	0.249 (0.253)	0.282 (0.296)	0.238 (0.253)	**Po**	0.260 (0.293)	0.193 (0.191)	0.337 (0.357)	0.215 (0.263)
	Ec	0.249 (0.251)	0.425 (0.461)	0.304 (0.330)	**Ne**	0.282 (0.338)	0.171 (0.174)	0.215 (0.226)	0.249 (0.322)
					Op	0.293 (0.326)	0.459 (0.491)	0.326 (0.336)	0.260 (0.313)
α=0.05 r'=0.136	**EI**	0.317 (0.344)	0.433 (0.499)	0.271 (0.303)	**En**	0.444 (0.504)	0.282 (0.276)	0.352 (0.354)	0.271 (0.323)
	In	0.213 (0.198)	0.248 (0.244)	0.201 (0.199)	**Po**	0.225 (0.240)	0.155 (0.131)	0.306 (0.309)	0.178 (0.208)
	Ec	0.213 (0.196)	0.398 (0.422)	0.271 (0.282)	**Ne**	0.248 (0.286)	0.132 (0.108)	0.178 (0.165)	0.213 (0.269)
					Op	0.259 (0.277)	0.433 (0.454)	0.294 (0.288)	0.225 (0.263)
α=0.01 r'=0.167	**EI**	0.292 (0.303)	0.412 (0.467)	0.244 (0.260)	**En**	0.424 (0.476)	0.256 (0.234)	0.328 (0.317)	0.244 (0.284)
	In	0.184 (0.151)	0.220 (0.200)	0.172 (0.152)	**Po**	0.196 (0.195)	0.124 (0.079†)	0.280 (0.268)	0.148 (0.160)
	Ec	0.184 (0.150)	0.376 (0.388)	0.244 (0.240)	**Ne**	0.220 (0.241)	0.100† (0.052†)	0.148 (0.112)	0.184 (0.223)
					Op	0.232 (0.235)	0.412 (0.423)	0.268 (0.246)	0.196 (0.220)

Note: Except for numbers with †, all correlations are significant at $p<0.05$ level (two tailed). The scale reliability of marker variable is 0.536 and correlations with En, Po, Ne and Op are 0.119, 0.132, 0.052 and 0.036†. The symbol r presents the smallest positive correlation, and correlations in parentheses represent $\hat{r}_{Yi\cdot M}$ in Lindell and Whitney (2001).

TABLE B2 Rotating Component Matrix for GSCM Pressures

	KMO=0.903, Cumulative % of Variance =63.71		
Index	**Market**	**Export**	**Cost**
Ma1	0.673		
Ma2	0.658		
Ma3	0.718		
Ma4	0.677		
Ma5	0.614		
Ma6	0.611		
Ma7	0.711		
Ma8	0.739		
Ma9	0.670		
Ma10	0.555		
Ex1		0.858	
Ex2		0.863	
Ex3		0.828	
Ex4		0.671	
Co1			0.719
Co2			0.703
Co3			0.813
Co4			0.832

TABLE B3 Rotating Component Matrix for GSCM Practices

Index	KMO=0.944, Cumulative % of Variance =61.45		
	External Improvement	Internal Improvement	Ecology
EI1	0.707		
EI2	0.739		
EI3	0.664		
EI4	0.639		
In1		0.679	
In2		0.649	
In3		0.714	
In4		0.736	
In5		0.780	
In6		0.585	
In7		0.554	
In8		0.545	
Ec1			0.728
Ec2			0.736
Ec3			0.774
Ec4			0.778
Ec5			0.730
Ec6			0.645
Ec7			0.627
Ec8			0.678
Ec9			0.642
Ec10			0.555

TABLE B4 Rotating Component Matrix for Enterprises' Performance

Index	KMO=0.937, Cumulative % of Variance=70.71			
	Environmental Performance	Positive Economic	Negative Economic	Operational Performance
En1	0.842			
En2	0.864			
En3	0.827			
En4	0.781			
En5	0.673			
En6	0.701			
En7	0.426			
Po1		0.722		
Po2		0.781		
Po3		0.809		
Po4		0.714		
Ne1			0.755	
Ne2			0.800	

(Continues)

TABLE B4 (Continued)

Index	KMO=0.937, Cumulative % of Variance=70.71			
	Environmental Performance	Positive Economic	Negative Economic	Operational Performance
Ne3			0.747	
Ne4			0.714	
Op1				0.760
Op2				0.781
Op3				0.794
Op4				0.816
Op5				0.709
Op6				0.716
Op7				0.515

TABLE B5 CFA Model Fit of Different Model Structures

Models	χ^2	df	p-value	χ^2/df	RMSE	Probability RMSE ≤ .05	CFI	SRMR
Original	3593.306	1933	0.000	1.86	0.047	0.965	0.907	0.051
Ma & Ex	4139.557	1943	0.000	2.13	0.054	0.001	0.876	0.054
Ma & Co	3662.949	1943	0.000	1.89	0.048	0.908	0.903	0.052
Ex & Co	3853.355	1943	0.000	1.98	0.051	0.317	0.893	0.065
Ex & EI	4168.68	1943	0.000	2.15	0.055	0.000	0.875	0.055
Ex & QR	3819.476	1943	0.000	1.97	0.050	0.437	0.894	0.060
EI & Ec	3865.075	1943	0.000	1.99	0.051	0.279	0.892	0.053
EI & En	4167.255	1943	0.000	2.14	0.055	0.000	0.875	0.064
EI & QR	3691.381	1943	0.000	1.90	0.048	0.854	0.902	0.052
In & Op	4400.507	1943	0.000	2.26	0.057	0.000	0.862	0.064
En & Po	3845.626	1943	0.000	1.98	0.051	0.343	0.893	0.056
En & Op	4213.852	1943	0.000	2.17	0.055	0.000	0.872	0.054
Po & Op	3761.798	1943	0.000	1.94	0.049	0.650	0.898	0.054

Note: "Ma & Ex" means the structure that is identical with the original one except for combining Ma and Ex factors.

TABLE B6 CFA Factor loadings and Standard Errors

Factors	Items	Estimate/Loading	S.E.	Est./S.E.
Ma by	Ma1	0.656	0.032	20.598
	Ma2	0.636	0.033	19.281
	Ma3	0.652	0.032	20.331
	Ma4	0.739	0.026	28.231
	Ma5	0.570	0.038	15.095
	Ma6	0.766	0.024	31.664
	Ma7	0.760	0.025	30.765
	Ma8	0.766	0.024	31.548
	Ma9	0.708	0.029	24.604
	Ma10	0.632	0.033	18.906

(Continues)

TABLE B6 (Continued)

Factors	Items	Estimate/Loading	S.E.	Est./S.E.
Ex by	Ex1	0.813	0.022	37.589
	Ex2	0.837	0.020	42.045
	Ex3	0.855	0.019	46.042
	Ex4	0.723	0.028	26.195
Co by	Co1	0.784	0.030	26.336
	Co2	0.801	0.028	28.126
	Co3	0.717	0.032	22.514
	Co4	0.722	0.032	22.725
EI by	EI1	0.812	0.022	37.422
	EI2	0.782	0.024	32.857
	EI3	0.799	0.023	35.192
	EI4	0.647	0.033	19.725
In by	In1	0.581	0.037	15.758
	In2	0.759	0.025	30.829
	In3	0.728	0.027	26.908
	In4	0.651	0.032	20.034
	In5	0.797	0.022	35.786
	In6	0.772	0.024	32.444
	In7	0.671	0.032	21.294
	In8	0.732	0.027	27.118
Ec by	Ec1	0.663	0.031	21.501
	Ec2	0.732	0.026	27.815
	Ec3	0.700	0.028	24.670
	Ec4	0.670	0.031	21.855
	Ec5	0.639	0.033	19.579
	Ec6	0.515	0.040	12.953
	Ec7	0.809	0.020	40.843
	Ec8	0.857	0.016	52.341
	Ec9	0.808	0.020	39.855
	Ec10	0.776	0.023	33.719
En by	En1	0.843	0.017	48.293
	En2	0.874	0.015	58.696
	En3	0.866	0.015	56.464
	En4	0.860	0.016	54.451
	En5	0.748	0.025	30.280
	En6	0.746	0.025	30.120
	En7	0.605	0.034	17.562
Po by	Po1	0.785	0.028	27.820
	Po2	0.833	0.024	35.118
	Po3	0.823	0.024	34.192
	Po4	0.764	0.029	25.969
Ne by	Ne1	0.673	0.036	18.885

(Continues)

TABLE B6 (Continued)

Factors	Items	Estimate/Loading	S.E.	Est./S.E.
	Ne2	0.723	0.033	22.183
	Ne3	0.739	0.031	23.782
	Ne4	0.716	0.033	21.578
Op by	Op1	0.792	0.022	35.565
	Op2	0.863	0.016	53.062
	Op3	0.838	0.018	45.603
	Op4	0.755	0.025	30.621
	Op5	0.768	0.024	32.418
	Op6	0.654	0.032	20.703
	Op7	0.801	0.021	37.687
QR by	QR1	0.746	0.036	20.600
	QR2	0.612	0.042	14.738
	QR3	0.677	0.038	18.022

$P < 0.001$ for all loadings.