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Research paper

Examining the antecedents and consequences of green product innovation

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ABSTRACT

As an important part of social innovation, green product innovation (GPI) is widely regarded as a beneficial strategy for firms to achieve sustainable success. While the way to effectively leverage GPI has not been fully invested. To address this lack, this study examines the antecedent role of inter-organizational control mechanism by investigating the nature of the interplay between formal control and social control in relation to green supply chain collaboration. In addition, we probe the impact of GPI on firm triple bottom line due to the inconsistent results in existing literature. Based on a sample of 239 senior managers and directors in the Chinese manufacturing industry, we test the hypotheses through moderated structural equations modelling. The results show that formal control and social control should be applied as complements in promoting GPI, while only working on Moreover, enhance the awareness and adoption of GPI stimulates better environmental performance and social performance as a result. The relationship between GPI and financial performance is mediated by both environmental and social performance. Our findings will help B2B participants understand the GPI and potential sustainable, social and economic outcomes, and support them formulate more effective control mechanism strategies.

1. Introduction

Recently within the business-to-business (B2B) domain, topics related to environmental management have been attracting increasing attention from both academics and practitioners. One main driver behind the development of environmental management is the corresponding pressure from environmental regulations and laws. In order to comply with requirements issued by national and international authorities, firms need to implement relevant policies and to integrate environmental consciousness into their operations. For example, the 2015 United Nations Framework Convention on Climate Change (UNFCCC) led to the Paris Agreement, which serves as a guide for future legislation and actions on environmental protection and has been making a great impact on firms' behaviour. China, as one of the signatories, officially proposed to cut carbon dioxide emissions per unit of GDP by 65% from the 2005's level by 2030. Varies of actions have been improved, like upgrading energy consumption structure, improving energy efficiency, decarbonising power supply, in which influence enterprises' behaviours in a great extent (Wang & Zhang, 2019). Another driver is the growing customer awareness of the environmental damage caused by industrial manufacturing activities, which has led to notable changes in customers' preferences and an increasing tendency to purchase green products (Wong, Lai, Shang, Lu, & Leung, 2012). Due to such dual pressure, it has become the norm for firms to develop strategies to lessen the environmental impact of their activities and to contribute to environmental protection (Zhang, Tse, Dai, & Chan, 2017). In this situation, green management eases the stresses by bringing superior performance and competitive advantage through the development and optimization of the human, business and technology resources in the formation of green capability (Gable, Lofgren, & Osorio-Rodarte, 2015),

As an important part of green innovation, green product innovation (GPI) has been conducted by firms to deal with the pressure from environmental regulations and customer expectation (Chan et al. Huang, Hu, Liu, Yu, & Yu, 2016). Compared to traditional product innovation, GPI involves additional environmental requirements in the product design process and adopts relevant regulations and rules to protect ecosystems from over-consumption of raw materials and energy, and to reduce waste generation and health and safety risks. To comply with these requirements, firms develop and apply new green technologies and knowledge. However, how a firm can effectively leverage GPI has not been fully investigated. In this study, the inter-organizational control mechanism in the green context is examined with regard to its

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antecedent role in promoting GPI. The reason for investigating the inter-organizational control mechanism is that it determines the behaviour of the company itself and of its supply chain partners (Clauss & Spieth, 2016; Das & Teng, 1998), and has been regarded as an important tool to benefit alliance participants through goal congruence and preference convergence (Clauss & Spieth, 2016; Geringer & Hebert, 1989). The literature distinguishes two main types of control mechanism: formal control, which uses formal written contracts to reduce opportunistic behaviour and conflict between parties; and social control, which builds trust between firms through social relations and shared norms (Cao & Lumineau, 2015; Zhou & Xu, 2012). There is a long history of investigating the roles of social control and formal control in determining the organizational behaviours in industrial marketing or inter-organizational relationship management (Claro, Hagelaar, & Omta, 2003; Lee, Shin, Hwang, Kuper, & Kang, 2018; Sharma & Pillai, 2003; Yu, Liao, & Lin, 2006). However, it is important to note that the governance mechanism in the green context is different from the generic supply chain management governance, which usually focuses on financial flow and product flow (Tachizawa & Wong, 2015). To date, there has been only limited research that scrutinizes such dual control mechanisms in the environmental management context (Tachizawa & Wong, 2015).

In addition to examining how the governance mechanism in the external green management context can improve GPI, another distinct research objective in this study is to understand the interplay between the two types of control mechanism. Previous research has shown that formal control and social control are not mutually exclusive; rather, they can act as substitutes (Li, Xie, Teo, & Peng, 2010; Wuyts & Geyskens, 2005) or complements (Das & Teng, 1998; Huber, Fischer, Dibbern, & Hirschheim, 2013), or have different interaction depending on the relationships between partners (Yang, Zhou, & Jiang, 2011). We aim to bring together two research streams, on the adoption of GPI and on the nature of companies' external governance regarding environmental management, in order to formulate a theoretical framework. The study thus strives to answer the first research question (RQ1): *"How does the inter-organizational control mechanism contribute to the development of GPI?"*

Initiating green management practices, especially GPI, might not be cost effective. In order to convince a practitioner to adopt GPI, it is necessary to state clearly what benefits it will bring to the company. Therefore, it is worth investigating the second research question of this study (RQ2): *"How does the adoption of GPI impact on organizational performance?"* To do so, first, we focus on firms' environmental and social performance, bearing in mind that there is extensive debate as to the relationship between GPI and firm performance, and that findings on this relationship are inconclusive (Ambec & Lanoie, 2008; Chen, Lai, & Wen, 2006; Gilley, Worrell, & Davidson Iii, 2000). Second, we scrutinize the indirect effect of GPI in enhancing financial performance, an area in which there has relatively limited empirical research (Short et al., 2016). To address the above research gaps, this study uses a large sample of primary data to examine the relationships among GPI, and firms' environmental, social and financial performance.

A review of the literature reveals huge differences among countries in terms of the GPI research, where most studies have been conducted in Europe. Given that there is considerable concern about environmental deterioration in developing countries, while there has been only limited research in those contexts (Dangelico, 2017), there have been calls for more empirical GPI research in emerging markets (Seebode, Jeanrenaud, & Bessant, 2012). In the context of China, violating the environmental laws and regulations could lead to the firms being shut down, while implementing GPI that results in avoiding environmental punishment, such as by consuming limited non-renewable resources, and discharging pollutions within emission standards (Zhang et al., 2017). Hence, it is necessary to use up-to-date data to fill the gaps in the literature. This study responds to those calls by testing the model using empirical data from 239 senior managers and directors in Chinese manufacturing firms with rational measurement scales.

In the following sections, we first provide a review of the literature and outline the development of the research model. Then, we present the moderated structural equations modelling methods. The results of the model are reported in Section 5, and discussed further in Section 6. Finally, in Section 7, we present conclusions and provide recommendations for future research.

2. Theoretical background

2.1. Inter-organizational control in the green context

Generally, inter-organizational governance concerns the design of organizational or structural arrangements to influence the behaviour of supply chain members or business partners (Das & Teng, 1998). Thus, choosing appropriate control mechanisms and applying them in an effective way are essential when managing inter-organizational relationships. According to Jap and Ganesan (2000), control mechanisms are safeguards for firms, used to govern intergenerational exchange and to enhance supplier commitment through supplier investment, relational norms and explicit contracts. The control of the inter-organizational relationships may be highly dynamic and complex, and there is much debate aimed at determining the most efficient governance or control mechanism to influence the behaviour of business partners or supply chain members (Abdi & Aulakh, 2017; Huang, Cheng, & Tseng, 2014; Li et al., 2010). Despite the multitude of control mechanisms, in general the literature distinguishes between two main types of governance mechanism, namely formal (i.e., contractual governance) and social (i.e., relational governance) (Cao & Lumineau, 2015).

Specifically, formal control is defined as the formal and written contract that explicitly regulates partners' responsibilities and obligations (Abdi & Aulakh, 2017), where a set of detailed instructions, regulations, rules and standardized work procedures is created to reduce the dangers of uncertainty (Youngdahl, Kellogg, Nie, & Bowen, 2003). In contrast, social control refers to the extent to which the inter-organizational relationship is managed by social ties, shared norms and trust (Cao & Lumineau, 2015; Poppo, Zhou, & Zenger, 2008; Zhou & Xu, 2012). Instead of depending on the formal structure of the agreements (e.g., explicit contract) or third-party enforcement, social control is usually based on an informal structure and relies on self-enforcement by each party in the business partnership (Dyer & Singh, 1998; Zhang et al., 2017). This dual classification can also apply in the context of external environmental collaboration. Surprisingly, however, although the dual governance mode in the green context is acknowledged in the literature to be conceptually important, there has been very little empirical research to examine the impacts of governance mechanism on firms' green behaviour (Tachizawa & Wong, 2015). Recent studies show that firms have increasingly use formal control and social control simultaneously in both domestic and international buyer-supplier cooperation (Li et al., 2010). However, inconsistent positions on the interplay between formal control and social control can be found in literature, one stream of research support the substitute relationship, while another stream of studies holding complementary relationship (Cao & Lumineau, 2015). The limitations constrain the use of control mechanism in improving green supply chain management of each party, so it is important to understand the relationships between formal control and social control.

In the context of green supply chain management, formal control mechanisms are regarded as a governance mechanism that takes the form of environmental assessment, auditing and reporting to influence the explicit behaviour of the supply chain members (Huang et al., 2014; Smart, Hemel, Lettice, Adams, & Evans, 2017; Tachizawa & Wong, 2015), and are common in business partnerships associated with pro-environmental practices. For instance, using a formal environmental management initiative, Nike controlled the environmental targets and performance of their suppliers in the Far East (Plambeck, Lee, & Yatsko,

2012). In 2018, Apple conducted over 700 audits of its upstream suppliers regarding their manufacturing facilities, logistics service and contact centre facilities to ensure the assembly parts of its products were certified as zero waste to landfill (Apple, 2018). According to Huang et al., 2014, the formal control mechanisms will normally specify the expected roles, partner responsibilities, expected process and output standards. The general clauses regulating or promoting the partners' behaviour, such as incentive systems and dispute resolution agreements, are also core to formal control mechanisms (Alvarez, Pilbeam, & Wilding, 2010). In the green context, a firm's formal control over its business partners could be reflected in enforced environmental disclosure (Longoni & Cagliano, 2018), formalizing environmental audit procedures (Miemczyk, Johnsen, & Macquet, 2012), setting emission reduction targets for suppliers (Chan, He, Chan, & Wang, 2012), or adhering to a list of restricted materials when purchasing raw materials or assembly parts from the suppliers (Tachizawa & Wong, 2015).

The above arguments are underpinned by transaction cost theory (TCT), according to which well-established contractual mechanisms are useful to specify each party's responsibilities and to minimize the opportunistic behaviour of business partners (Chen, Ganesan, & Liu, 2009; Liu, Luo, & Liu, 2009; Lui, Ngo, & Hon, 2006). However, although the TCT perspective has been widely applied in the discussion of formal control mechanisms (Li et al., 2010; Wacker, Yang, & Sheu, 2016), it is not widely used in the environmental management context. Moreover, TCT is subject to the criticism that the stated effectiveness of formal control mechanisms is constrained by certain specific conditions, such as bounded rationality and opportunism (Cao & Lumineau, 2015; Goo, Kishore, Rao, & Nam, 2009). Lee, Plambeck, & Yatsko, 2012 argue that the reliability of formal control in the green context, such as environmental standards, is compromised by the commoditization of auditing systems and by corruption. Moreover, TCT may be too narrow to sufficiently explain how firms can adopt appropriate control mechanisms in their inter-organizational relationship (Li et al., 2010). In addition to the logic of transaction costs, social relation is another important logic underlying the firms' behaviour in economic exchange or business partnership. In that regard, the social exchange theory (SET) maintains that social control offers another governance mechanism, as an alternative or complement to formal control.

Social control, which is also known as “relational governance”, usually takes the forms of trust and relational norms (Cao & Lumineau, 2015). According to SET, the inter-firm cooperation normally includes not only the economic dimension, but also the social dimension (Li, Liu, Li, & Wu, 2008). Nooteboom, Berger, and Noorderhaven (1997) indicate that social relations impact on economic behaviour. In economic exchanges, the realization of the contract relies heavily on the shared norms and social ties within the business partnership. Actors in the inter-organizational relationship can become more committed to the collaborations that influence their behaviour through socialization, personal familiarity and joint problem solving (Cousins, Handfield, Lawson, & Petersen, 2006; Huang et al., 2014). The studies in inter-firm relationship governance particularly acknowledge the importance of trust (Handfield & Bechtel, 2002; Kwon & Suh, 2004). As one of the most important characteristics of social control mechanisms, trust is highly associated with the positive expectations of the business partners that they will each operate in good faith (Lui, Wong, & Liu, 2009). According to the rule of reciprocity in SET, such expectations will motivate the partners to regularly discharge their obligations to invest in the relationship (Lambe, Wittmann, & Spekman, 2001). Therefore, the SET theorists suggest, social control mechanisms that emphasize trust are considered to be a good investment for governing the inter-organizational relationship (Cao & Lumineau, 2015; Lui et al., 2009; Shahzad, Ali, Takala, Helo, & Zaefarian, 2018).

Studies in the field of environmental management, social control takes the form of a structural agreement designed to impact on the environmental-oriented behaviour of supply chain partners based on trust and social ties, rather than formal regulations (Blome, Schoenherr, & Kaesser, 2013; Tachizawa & Wong, 2015). Especially for the researchers which focused on the emerging market, they have either conceptually proposed or empirically validated the important role of social control mechanisms in contributing to the improvement of external environmental practices. This is because in the Asian markets, such as China, the social and business environment is commonly characterized as relationship based. This unique type of relational network is running on favour exchange and mutual obligation (Chen, Huang, & Sternquist, 2011). Lee et al. (2016) also argue that in China, the focal company and its supply chain members can only be bound tightly together by mutual trust and favour exchange until they build up significant relational connection. Social connection has been proved to be a positive moderator of the adoption of GSCM in Asian emerging markets by Geng, Mansouri, Aktas, and Yen (2017). Using a sample of Chinese senior managers in the manufacturing industry, Zhang et al. (2017) find that social control mechanisms can strengthen the relationship between GSCM and financial performance. Moreover, Zhu, Feng, and Choi (2017) claim that in order to achieve economic performance improvement through green innovation, companies need to develop cooperation and reciprocity with their customers. Although the literature has started to discuss the roles of social control mechanisms in the context of environmental management, how they can interplay with the formal control remains an open question in the field (Zhang et al., 2017).

Surprisingly, although the dual governance mode in the green context is acknowledged in the literature to be conceptually important, there has been very little empirical research to examine the impacts of governance mechanism on firms' green behaviour (Tachizawa & Wong, 2015). Besides, the interplay between formal control and social control still remains equivocal (Cao & Lumineau, 2015). Recent studies show that firms have increasingly use formal control and social control simultaneously in both domestic and international buyer-supplier cooperation (Li et al., 2010). However, inconsistent positions on the interplay between formal control and social control can be found in literature, one stream of research support the substitute relationship, and another stream of studies holding complementary relationship (Cao & Lumineau, 2015). The limitations constrain the use of control mechanism in improving green supply chain management of each party, so it is important to understand the relationships between formal control and social control.

2.2. Green product innovation

According to Grønhaug and Kaufmann (1988), new product innovation is increasingly recognized as a major factor in sustaining firms' competitive advantage. With regard to the internal aspect, new product innovation brings advanced knowledge, capacities, resources and technologies to firms; while as regards the external aspect, customer demand or institutional expectation can be met by new function and design (Reguia, 2014). As public recognition of the consequences of environmental degradation has grown, customers have started to assess products in terms of their impact on the environment, while firms from both developed and developing countries have begun to integrate such concerns in product innovation, a practice termed GPI. This research adopts Chen et al., 2006 definition of GPI, as “*product innovation that is related to environmental innovation, including the innovation in products that are involved in energy-saving, pollution-prevention, waste recycling, no toxicity, or green product designs*”. GPI contributes to firms' sustainable competitive advantage through the development of eco-friendly technology, knowledge-base and capacities, as well as by satisfying customer demand for eco-friendly products. There is a significant body of literature that explores how firms can engage in better environmental behaviour, and the performance outcomes of such behaviour. As GPI has become one of the most important concepts in environmental management, both empirical and conceptual studies have made

remarkable efforts in proposing and testing various theoretical frameworks related to this issue (Dangelico, 2016).

The factors that drive firms to extend their engagement in GPI can be classified into two groups, namely internal antecedents and external antecedents. With regard to the former, companies' green culture and pressure from internal stakeholders are widely regarded as the major drivers of GPI. For example, the ecological responsibility that derives from a company's concerns regarding its social obligations has been found to be significantly and positively associated with GPI development (Chang, 2011). Recently, using a sample collected from the hotel sector, Gürlek and Tuna (2018) empirically confirmed the positive impact of green organizational culture on green innovation. With regard to the external antecedents, the existing studies largely rely on the institutional theory to identify the external factors that drive companies to initiate GPI. In the institutional context, organizations are expected to have appropriate, fundamental and meaningful behaviour that is consistent with the rules, norms and ideologies of society (Zucker, 1983). The institutional theory has been extensively used in the literature that shows the different roles of market (such as customer demand and market stakeholder pressures) versus non-market (such as the current and/or expected environmental regulations and policies) constituents in firms' promotion of environmental practices (Chan, Yee, Dai, & Lim, 2016; Chen, Yi, Zhang, & Li, 2018; Dai, Chan, & Yee, 2018; Huang et al., 2016; Sanni, 2018). Although the antecedents of GPI improvement constitute an important topic, and have been studied for a long time, there is still very little research that provides a bridge between the fields of inter-organizational relationship governance and GPI.

We argue that it is essential for firms to realize that the appropriate adoption of control mechanisms has an important influence on GPI. For green-oriented firms, control mechanisms influence transaction expenditures, cooperation expenditures, and partners' willingness to participate in green innovation activities (Li et al., 2010). Internal social activities are channels of organizational learning for staff, which develop the firm's knowledge base and inspire new ideas about green innovation (Mohr & Sengupta, 2002), while external social activities between focal firm and suppliers, or focal firm and customers, create more interactions and communication, thus promoting trust among participants and improving efficiency in the knowledge exchange (Tachizawa & Wong, 2015).

In a marketplace characterized by growing governmental and societal concern over environmental issues, the natural resource-based view (NRBV) theory suggests that companies are more likely to obtain competitive advantages if they can integrate environmental considerations into their strategic planning (Hart, 1995). In line with the NRBV, many empirical studies have confirmed the positive relationship between GPI and firm performances. For example, GPI development has been found to be positively associated with cost savings (Chiou, Chan, Lettice, & Chung, 2011), increased sales and market share (Leenders & Chandra, 2013; Leonidou, Katsikeas, & Morgan, 2013), higher profits and return on investment (Leenders & Chandra, 2013). However, other studies have concluded that GPI does not have a significant impact on financial performance (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013; Tang, Walsh, Lerner, Fitza, & Li, 2018). The literature suggests that environmental management practices make firms more environmentally friendly and socially responsible, thus creating business value and profitability (Feng et al., 2018; Klassen & McLaughlin, 1996; Zailani, Govindan, Iranmanesh, Shaharudin, & Chong, 2015). Moreover, in order to gain greater insights of the relationship between GPI and firm performance from existing knowledge, we listed some recent published key studies that focusing on Chinese or Taiwanese context (see Table 1), information like definition and connotation of green product innovation, samples have adopted, research methods have used to address green issues, types of performances, and key findings they make. As a result, the number of studies mainly embracing the understating of GPI on environmental performance and financial performance, none of them empirically investigate triple bottom line. Also, inconsistent results on the indirect relationship among performances can be found. In other words, the impact of green practices on firm performance is indirect, through improved ecological efficiency and better social performance (Feng et al., 2018; Zhu & Sarkis, 2004; Zhu, Sarkis, & Lai, 2013). However, questions remain as to whether such mediation effects of social and environmental performance apply to GPI, which is one of the most important environmental management practices available to firms. Due to the inconsistent results between GPI and financial performance, limited understanding of how GPI impact ecological and social performance in the context of China, we therefore specifically study whether GPI could be valuable in facilitating firm's triple bottom line simultaneously. (See Table 2.)

3. Hypothesis development

3.1. Control mechanisms and green product innovation

Organizational behaviour is constrained by both formal and informal institutions, where those organizations that meet institutional expectations would have a higher possibility of survival in the market. Given the potential losses from institutional pressure, firms are more willing to engage in appropriate behaviour, hence it becomes a key concern for organizations to know the correct ways to respond to and comply with the demands of the institutional environment. With regard to the formal aspect, Dangelico (2016) claims that environmental regulations have been recognized as the most important external driver for the development of GPI, and in this respect, government plays a critical role through its responsibility for legislation, regulation and enforcement. In China, for example, the Environmental Protection Law (2014) includes measures to control the behaviour of companies.

For the companies themselves, the exercise of strong formal control is an effective strategy to respond to the formal institutional environment. Such control specifies the rights and duties of buyers and suppliers, and benefit firm's GPI from different perspective. Unlike relational governance, which usually takes extensive time and resource to develop (Das & Teng, 1998), written contracts minimize negotiation time and transaction costs through better understanding of the environment and contributes to the knowledge exchange for the GPI (Cao & Lumineau, 2015), thus enables organizations to adapt rapidly to the legal environmental (Choi & Wong, 2007). In addition, formal regulation provide explicitly stipulates the environmental responsibilities and regulation to guide each participant to act in appropriate ways, and the effective conduct of formal contract can effectively response the external requirements for environmental protection, while also avoid to be affected by opportunistic behaviour or lack of adaptation (Dyer & Singh, 1998). Moreover, Recent research also shows that contractual governance significantly benefits the coordination and adaptation of inter-organizational relationships (Cao & Lumineau, 2015). When both parties agree with bilateral credible commitments in ecological development, contractual parties depend on each other for preserving common reputation and earning repeat business (Schepker, Oh, Martynov, & Poppo, 2014), thus each of them is more likely to building better cooperation and maximizing joint return.

Social control is governed by social relations and shared norms (Zhou & Xu, 2012), and exerted through: (1) building informal structures, also referred to as relational norms, which indicate the shared expectations for each party's behaviour and provide a framework of references for the required behaviours, and (2) self-enforcement, which embodies the mutual trust among parties by regulating the companies' own actions, while providing assurance that other parties will not engage in adverse behaviours, even under risk (Cao & Lumineau, 2015). When a firm adopts GPI as a response to social control, this brings social legitimacy (Shu, Zhou, Xiao, & Gao, 2016). Specifically, when a firm's act, process or ideology becomes legitimate due to conformity with informal institutional pressure, this minimizes the possibility of

Table 1
Existing knowledge of green product innovation and firm performance.

Article	Definition and Connotations of Green Product Innovation	Sample	Method	Type of performance	Key findings
Chen & Liu, 2019	Green product innovation is the introduction of a product or service that incorporate new features that take environmental concerns into account	195 firms from manufacturing sectors using provincial government directories in China from June 2017 to February 2018	Survey	Firm performance (operationalized based on three items: return on sales, return on asset, return on investment)	Performance implications of green innovation (including green product innovation and green process innovation) are moderated by competitive strategies, and the effects are more prominent in a high competitive intensity.
Xie, Huo, & Zou, 2019	Green product innovation implies the improvement of product designs via using nontoxic compounds or biodegradable materials throughout the whole production process with the purpose of reducing negative environmental impact and improving energy efficiency (Lin, Tan, & Geng, 2013)	A data set of 209 firms listed in the publication Stock A Markets of Shanghai or Shenzhen Stock Exchange in 2013	Secondary Data	Financial performance	Green product innovation can improve a firm's financial performance
Tang et al., 2018	Green product innovation refers to the production of a new product or service that brings no harm on the environment of existing current or competing product (Wong et al., 2012)	188 manufacturing firms in China	Survey	Firm performance (operationalized based on five items: sales value, market share, return on investment, firm image and customer satisfaction)	Green product has a positive main effect on firm performance
Huang and Li, 2017	Green product innovation is the product innovation that involves environmentally friendly material, environmental friendly packaging, recovery of products and recycling, and eco-labelling (Chen et al., 2006; Chen, 2008)	418 companies in different industry sectors selected from Taiwan Stock Exchanges and the online Business Directory	Survey	Environmental performance and organizational performance	Green product and process innovation have positive effects on environmental performance and organizational performance
Li, Jayaraman, Paulraj, & Shang, 2016	Green product design minimizes the product environmental impact over its life cycle and improve firm's sustainable competitive advantages as return.	256 Chinese-based high-tech firms	Survey	Environmental performance and financial performance	Green product design plays a significant role in improving firms' environmental and financial performance, while green product innovation may not have a direct impact on financial performance
Chan et al., 2016	Green product innovation takes the environmental factors into product design considerations for both new and existing products, with the main objective to decrease the negative environmental impacts over the products' life-cycle (Chang, 2011, Dangelico, Pujari, & Pontrandolfo, 2017)	250 responses from variety of industries in China from April 24 to May 8, 2015	Survey	Firm performance (Cost efficiency and firm profitability)	Green product innovation is a key capability for competiveness due to its ability to bring firms not only cost efficiency but also profitability

Table 2
Demographic information.

	Frequency	Percentages (%)
Firm size		
< 300	65	27.2
300–2000	151	63.2
> 2000	23	9.6
Job position		
CEO	195	81.6
Purchasing Manager	33	13.8
Supply Chain Manager	8	3.3
Project Manager	3	1.2
Income (Chinese Yuan - MILLION)		
Less than 50	44	18.4
50–200	144	60.3
More than 200	51	21.3
Company base region		
North China	57	23.8
Northeast China	10	4.2
Eastern China	71	29.7
Central China	17	7.1
South China	51	21.3
Southwest China	20	8.4
Northwest China	13	5.4
Industry sector		
Electronic and other electrical equipment and components, except for computer equipment	110	46
Pharmaceutical industry	64	26.8
Automotive industry	65	27.2

external accountability, while also helping the firm to gain network power through the enhanced level of trust from its partners and customers (Li et al., 2010). Furthermore, Arfi, Hikkerova, and Sahut (2018) argue, in order to fulfil the green innovative tasks, such as forming the cross-functional teams with an assigned environmental target, the employees need to absorb and exchange the tacit knowledge (e.g. skills or experience) with their colleagues or applying explicit knowledge existing in the company. In order to accomplish GPI, the involved business partners or supply chain members need to actively take part in the relevant product development process where embedded the tacit knowledges (Abbas & Sağsan, 2019). The forms of social control mechanisms, such as joint decision-making and frequent communication are required in this process. In summary, we propose two hypotheses as follow:

H1. : Formal control positively affects green product innovation.

H2. : Social control positively affects green product innovation.

Given that control mechanisms are highly relevant to firms' organizational coordination, the sustainability of structure and regulation, and discrete network consolidation (Grandori & Soda, 1995), this raises the question of how best to manage those control mechanisms. The literature has suggested two main ways of interplay between formal control and social control, namely complement and substitution (Huber et al., 2013; Li et al., 2010; Zhang & Zhou, 2013).

We argue that in the case of Chinese green-oriented firms, the most effective way to promote GPI is to adopt both formal control and social control simultaneously as complements. We agree with Huber et al. (2013) that when used in this way, formal control and social control can each compensate for the limitations of the other. For example, although the Chinese government is consistent in emphasizing the importance of environmental protection, the relevant laws are still developing. In the absence of a complete regulatory framework backed up by legislation, firms draw up their own clauses relating to environmental issues, and monitor and measure their effects. To give a specific example, to date there is no legislation that regulates the consumption of non-renewable energy sources such as coal, oil and gas for a single project. Without specific guidelines, it is difficult to determine whether the amount of non-renewable energy the firm or its partners consume during the manufacturing process can be justified as acceptable, so they could decide to consume more energy while disregarding the negative impact on the environment. In this situation, where gaps in company regulation mean that formal control does not effectively prohibit environmentally damaging activities, social control can be an invaluable complement, providing opportunities for interaction between the firm and its suppliers where they can discuss and decide upon the level of consumption of non-renewable energy and monitor each other to ensure achievement of the mutual goal of environmental protection.

At the same time, formal control can operate as the complement of social control. According to Das and Teng (1998), it usually takes considerable time and resources to develop a relationship among parties, and this relationship could be vulnerable, especially under a situation of risk. For example, during their social control activities, the focal firm and its supplier might determine amounts of carbon dioxide emission and sewage discharge. However, due to the diverse nature or workload of different manufacturing procedures, the amount might not be equally distributed between parties, and the firm with the higher emission or discharge might feel more vulnerable to incurring fines. Such uncertainty could be resolved by formal control, where the establishment of contractual governance ensures that all parties reach agreement beforehand, and the whole supply chain and manufacturing operation will work together to minimize damage to the ecosystem.

In addition to acting as complements for each other, both formal control and social control create appropriate conditions for enabling the other. For example, social control attaches great importance to the communication and interaction between suppliers and buyers, where they can share and exchange experience, thus promoting the generation of new intangible resources such as knowledge about the adoption of GPI (Wang, Yeung, & Zhang, 2011). However, the experience of managing knowledge-based alliance is still limited in China, and firms would struggle to handle those valuable resources via social activities alone. In this situation, the formal contract could include clauses that enable the manufacturer and suppliers to record and develop new knowledge resources and information, which could accelerate the transfer of knowledge among participants (Zhang & Zhou, 2013). Consequently, it is claimed that formal control and social control should be used together to achieve GPI in China.

H3. : The use of formal and social control mechanisms will function as complements in promoting green product innovation.

3.2. Green product, environmental performance and social performance

According to Cooper (2004), social performance refers to firms' behaviour as regards shared social values when transferring mission into practice, in particular evidence of corporate social responsibility on issues such as environmental degradation and protection. Drawing upon Ranganathan (1998), who proposed four key elements of social performance, we provide further explanations as to how GPI positively influences firms' social performance. First, GPI involves not only the manufacture of eco-friendly products, but also the implementation of strict standards to ensure a better working environment that prioritizes employees' safety and protects them from the effects of toxic pollution. Secondly, by complying with legislation or regulations though, for example, reducing waste of resources and ecological damage, firms display their social responsibility and contribute to an eco-friendly community (Chen et al., 2006). Thirdly, under the constraint of institutional pressure, it becomes a moral question whether or not to cause detriment to the environment in order to pursue corporate interests. GPI provides an optimal solution to address ecological-related ethical issues through the innovation of new products with little harm to the ecosystem (Chang, 2011).

As a proactive environmental practice, GPI is widely being

recognized as one of the most effective strategies to reduce environmental damage, because it integrates the environmental consideration into the designs and packaging of the products (; Dangelico et al., 2017; Kam-Sing Wong, 2012; Noci & Verganti, 1999). For example, by designing the products that made by the environmental-friendly materials, firms can reduce waste and emission in productions (Tseng, Tan, & Siriban-Manalang, 2013; Zhang, Tse, Doherty, Li, & Akhtar, 2018). Environmental performance is about how good the company in reducing carbon dioxide and harmful gas emissions resulting from the firms' activities, such as production and transportation (Dubey, Gunasekaran, & Ali, 2015). By reducing the environmental effects of the resources consumed in the production, this study proposes the GPI will be helpful to enhance firm's environmental performance. The positive relationship between GPI and environmental performance was examined by several studies (Chiou et al., 2011; Dangelico et al., 2017; Seman et al., 2019). However, the results of such relationship has still not reached a conclusive result (Seman et al., 2019). Therefore, we propose to contribute to the literature by re-examining whether the GPI do affect environmental performance. Thus, we propose:

H4. : Green product innovation will positively affect social performance.

H5. : Green product innovation will positively affect environmental performance.

3.3. Environmental, social and financial performance

A high level of environmental performance is associated with reductions in environmental pollution, consumption of hazardous materials, and environmental accidents (Feng et al., 2018). Good environmental performance leads to cost saving and resource efficiency, hence to improve financial performance (Sarkis, 2003). According to Feng et al. (2018), environmental performance can be enhanced by the implementation of green technologies, which prevent pollution and reduce the costs resulting from environmental spillage and liability; specifically, the firms will be able to cut expenditure on waste disposal, pollution control, energy and material consumption. Meanwhile, the substantial reductions in waste and hazardous substances help firms to avoid penalties for violating environmental regulations and laws (Li et al., 2016). Furthermore, previous research (e.g., Feng et al., 2018; Hart, 1995) implies that good environmental performance provides legitimacy for firms to operate and even brings enhanced profit margins via the establishment of new industry standards. Firms can gain more market share when their competitors are not capable of reaching the same high standard of environmental performance. Therefore, the pursuit of environmental performance can synergically increase firms' overall profit margin and market share with lower cost.

The social dimension of sustainability is found in the influence of an organization's behaviour on different aspects of society, including its employees, customers, community, supply chain, and business partners (Alfred & Adam, 2009). This study assumes that social performance positively influences financial performance. This is because, by weighing and addressing environmental concerns in a fair and rational manner, high social performance satisfies various stakeholder groups, thus reinforcing the firm's competitiveness and benefiting organizational financial performance (Orlitzky, Schmidt, & Rynes, 2003). As with environmental performance, social excellence assures the organization's licence to operate and meets the changing stakeholder demands for environmentally-friendly products and services, which, in turn, support the organization's ability to deliver high quality economic performance. Moreover, high social performance bolsters the firm's operational efficiency and the managerial competencies that influence organizational culture, structure, technology and human resources, and brings both internal and external benefits (Barney, 1991; Orlitzky et al., 2003; Russo & Fouts, 1997). In addition, by increasing communication with external society about environmental protection and green innovation, social performance helps the firm to build a positive reputation and goodwill with its external stakeholders, which will improve financial performance by attracting more investment from bankers or investors, facilitating the appointment of better employees and increasing the customer base (Spicer, 1978). Therefore, we posit that social performance is positively correlated with firms' financial performance.

H6. : Environmental performance positively affects financial performance.

H7. : Social performance positively affects financial performance.

3.4. The mediating effects of environmental performance and social performance

In an institutional environment that places high value on social responsibility, it is likely that there will be resistance against, or even outright rejection of, products that are seen as detrimental. Such products might contravene environmental protection law, or simply fail to fulfil consumer expectations. Conversely, by incorporating ecological or “green” concerns into firm operations companies not only comply with formal institutional requirements, but can also increase their overall efficiency by reducing waste, energy consumption and the emission of dangerous substances (Zhang & Walton, 2017), thus avoiding the costs that would be incurred by implementing invalid practices or even manufacturing substandard products (Chen et al., 2006).

Unlike traditional product innovation, which emphasizes economic growth or cost efficiency, GPI takes into account both economic and environmental benefits, and integrates customers' environmental concerns into the whole business process (Ghisetti & Pontoni, 2015). Such improvements in both environmental and societal dimensions will result in higher customer satisfaction and therefore increased profit and market shares (Dangelico, 2016). Moreover, GPI usually requires the adoption of novel technologies. According to the resource-based view (RBV), when a company creates unique knowledge and resources that are very difficult for other companies to imitate, the focal firm would benefit more from its innovation and become more competitive than its rivals (Zhang & Walton, 2017). Given the preference of customers to purchase products that do not have a harmful impact on the environment, GPI can help firms to increase sales of their products, and thus ensure a more stable profit.

In addition to meeting customers' demand for functionality, green products can also fulfil people's psychological needs with regard to environmental protection (Pujari, 2006). If firms continue to engage in conventional product development instead of GPI, this will represent a refusal to take social responsibility with regard to the environment, which will cause serious problems in the future (Lin et al., 2013). Hence, firms with high GPI ability, whose brand image is associated with an eco-friendly concept, will find it easier to thrive in the market than their more traditional competitors.

Overall, we argue that GPI are not dedicated to help firms directly improve income and reduce costs. GPI is implemented for better social images and achieving environmental sustainability. In line with the arguments of Feng et al. (2018), the green practices do not directly lead to the superior financial performance. Instead, it is the better environmental and social performances as the results of GPI development that enables firms to enhance financial performances. Therefore, we propose the impact of GPI on financial performance is indirect through improving environmental and social performance. Thurs, we propose the following hypothesis:

H8. : The effect of green product innovation on financial performance is fully mediated by environmental performance and social performance.

Table 3
Measurement scales and loadings.

		Factor loading	Reference
Formal control (p_r = 0.837; AVE = 0.508)			
FC1	The contract precisely defines the role/responsibilities of the partner and our firm.	0.633	(Ferguson et al., 2005; Li et al., 2010);
FC2	The contract precisely states how each party is to perform in cooperation.	0.750	
FC3	Generally, the contract is a primary mechanism to regulate the behaviour of the partner in cooperation.	0.784	
FC4	The relationship with our supply chain partners is governed by rules and regulations of contract.	0.682	
FC5	Contract changes as client's business changes. (reverse coded)	0.705	
Social control (p_r = 0.850; AVE = 0.532)			
SC1	Reliance on the partner to keep promises.	0.774	(Li et al., 2010)
SC2	Participatory decision-making.	0.706	
SC3	Joint problem solving.	0.748	
SC4	Fine-grained information exchange.	0.759	
Green product innovation (p_r = 0.858; AVE = 0.547)			
GPI1	We are continually improving the design of our products to use more recycled materials.	0.789	(Chan et al., 2016; Zhang et al., 2018)
GPI2	We are continually improving the design of our products to avoid or reduce the use of hazardous products.	0.740	
GPI3	We are using eco-labelling.	0.718	
GPI4	Using less or non-polluting/toxic materials. (Using environmentally friendly material).	0.720	
GPI5	Recovery of company 's end-of-life products and recycling.	0.728	
Financial performance (p_r = 0.853; AVE = 0.592)			
FP1	Return on asset.	0.768	(Cao & Zhang, 2011, Flynn, Huo, & Zhao, 2010)
FP2	Growth of sales.	0.774	
FP3	Return on investment.	0.793	
FP4	Growth in return on investment	0.742	
Social performance (p_r = 0.868; AVE = 0.569)			
SP1	Improvement in overall stakeholder welfare or betterment.	0.746	(Paulraj, 2011)
SP2	Improvement in community health and safety.	0.729	
SP3	Reduction in environmental impacts and risks to general public.	0.705	
SP4	Improvement in occupational health and safety of employees.	0.839	
SP5	Improved awareness and protection of the claims and rights of people in community served.	0.747	
Environmental performance (p_r = 0.849; AVE = 0.585)			
EP1	Reduction of wasted water	0.702	(Feng et al., 2018, Zhu et al., 2010)
EP2	Reduction of solid wastes	0.827	
EP3	Decrease in frequency for environmental accidents	0.743	
EP4	Improve a company's environmental accidents	0.782	

4. Methodology

4.1. Data collection, non-response bias and common method bias

To examine the theoretical model developed for this study, a sample of Chinese manufacturing companies was collected. To ensure the content validity, we organized an expert panel, made up of three experienced practitioners and three OM researchers, to make a preliminary review of the questionnaire items used to measure our proposed constructs. Because the focus of this study is GPI, which is a resource-demanding practice, enterprises with limited resources might be outside the research scope. Therefore, we imposed three sample filter conditions, namely targeted firm size, targeted industries and job position. Specifically, qualified respondents should be at middle management level or higher in a manufacturing company with more than 150 employees (Zhang et al., 2017). Moreover, to ensure the informants have enough knowledge to understand the questions and have involved the decision makings related to the GPI. This study only collects the responses from the senior managers or decision maker of the companies, such as CEO, purchasing manager, supply chain manager and project manager. Because the study context is China, the English questionnaire was translated into Chinese using the back translation method (Brislin, 1980). We hired a Chinese market company to collect the data via an online questionnaire platform from a merged contact list containing contact information of 1630 firms. Overall, we obtained 239 valid responses, representing a 14.66% response rate. A chi-square (X^2) test conducted to examine the non-response bias yielded an insignificant result, indicating that there was no difference between the early-response group (n = 132) and late-response group (n = 107) in terms of firm size (X^2 = 0.206, df = 2, p = .902) or annual revenue (X^2 = 1.822, df = 2, p = .402) at the level of 0.1. Therefore, we can conclude that non-response bias is not a threat to this research.

As the data for this study were collected from single informants from each company, common method bias might be a potential problem (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Following Paulraj, Lado, and Chen (2008), we examined two CFA models, of which one only retains the original structure and one included a common latent factor in addition to the traits. The results show that the factor loadings of two models' constructs were not much different, and the t-values of the items remained significant despite the inclusion of the method factor. Moreover, the common latent factor accounted for 4.25% and marginally improved the model fit. Therefore, we can conclude that CMV is not a significant issue in this study. We also adopted confirmatory factor analysis (CFA) to reinforce the results of the common method bias test. Twenty-eight question items in our studies were formed as a single factor. The poor model fit (X^2/df = 7.269, CFI = 0.692, IFI = 0.695, GFI = 0.652 and RMSEA = 0.108) for the single factor model indicates that the CMB problem is not a concern in this research.

4.2. Measures

The measurements for all the proposed concepts are all adapted from the existing studies and they are listed in the Appendix. The scale of GPI that measuring firm's product development with regard to the environmental perspective, such as using eco-friendly materials and reducing the use of hazardous products, was adapted from Zhang et al. (2018) and Chan et al. (2016). Regarding the control mechanisms, we

Table 4
Means, standard deviations, Cronbach's alpha and discriminant validity test.

	α	Mean	Std.	1	2	3	4	5	6
1. Green product innovation	0.854	4.700	0.811	**0.740**					
2. Formal control	0.836	4.736	0.752	0.673*	**0.713**				
3. Social control	0.833	4.757	0.739	0.514*	0.499*	**0.729**			
4. Financial performance	0.851	4.664	0.798	0.713*	0.616*	0.464*	**0.770**		
5. Social performance	0.867	4.711	0.722	0.671*	0.696*	0.512*	0.715*	**0.755**	
6. Environmental performance	0.849	4.642	0.817	0.648*	0.543*	0.570*	0.702*	0.739*	**0.765**

Note: Diagonal entries (in bold) are average variances extracted; entries below the diagonal are correlations.
* Significant at 0.001 level; α indicates Cronbach's alpha.

Table 5
Results of hypotheses H1, H2, H3, H4, H5, H6 and H7 using MSEM.

Path	*β*	*t*-value	*p*-value
Control effects			
Firm size - > Social performance	−0.145	−2.716	0.007**
Firm size - > Environmental performance	0.061	1.101	0.271
Firm size - > Financial performance	0.032	0.619	0.536
Firm size - > Green product innovation	−0.024	−0.451	0.652
Main effects			
H1: Formal control - > Green product innovation	0.047	0.735	0.462
H2: Social control - > Green product innovation	−0.242	−3.434	***
H4: Green product innovation - > Social performance	0.750	9.293	***
H5: Green product innovation - > Environmental performance	0.738	8.692	***
H6: Environmental performance - > Financial performance	0.234	2.513	0.012*
H7: Social performance - > Financial performance	0.256	2.616	0.009**
Interaction effect			
H3: Formal control x Social control - > Green product innovation	0.873	10.317	***

Model fit: Chi-square (df) = 21.683 (1); IFI = 0.911; TLI = 0.455; CFI = 0.909; RMSEA = 0.384
* Significant at 0.05 level; ** Significant at 0.01 level; *** Significant at 0.001 level.

used the existing scales from Li, Xie et al. (2019) and Ferguson, Paulin, and Bergeron (2005), but modifying the questions by applying a context of green collaboration with the supply chain members. For example, in the questions related to the social control, the respondents were asked to evaluate the used of control mechanism such as participatory decision-making and joint problems solving in the environmental collaboration with the business partners. Regarding the measurements of performances, the respondents were asked to compare their current financial performance (Cao & Zhang, 2011), environmental performance (Zhu, Geng, & Lai, 2010) and social performance (Paulraj, 2011) over the last three year. The 7-point Likert scale for three firm performances measurements range from 1 – "decreased significantly" to 7 – "increased significantly". The descriptive statistics, including mean, standard deviation and correlation of the proposed constructs are provided in the Table 3. (See Tables 4 and 5.)

4.3. Reliability and validity of the constructs

Before testing the theoretical model, EFA and CFA were applied to examine the reliability of all the proposed constructs in this study. First, EFA was performed through principal component analysis for each construct with the corresponding indicators. The results showed that for the five factors solutions, all the factor loadings were greater than the threshold value of 0.5 (Netemeyer, Bearden, & Sharma, 2003). Therefore, the unidimensionality was confirmed. This finding was supported by the CFA, which revealed good model fit indices for the five factors solutions. To check the construct reliability of the five factors generated from the EFA, Dillon-Goldstein ρ - composite reliability (cf. Henseler, Ringle, & Sinkovics, 2009, p. 300) was calculated. As shown in Appendix, all five p_r were greater than 0.837, exceeding the minimum recommended value of 0.7. Therefore, we can conclude that the measurements adopted in this research are reliable.

This study applied CFA to examine the convergent and discriminant validity (O'Leary-Kelly & Vokurka, 1998). Due to the significant factor loadings in the CFA model, which all exceed 0.70 (with t-value greater than 2.0), the convergent validity was supported. The good model fit of CFA also provides evidence for the convergent validity (CFI = 0.969, IFI = 0.970 and NNFI = 0.965). Further, as suggested by Hair (2006), the root mean square error of approximation (RMSEA) and the value of X^2/df were checked. With RMSEA = 0.036 and X^2/df = 1.310, the indicators were below the thresholds of 0.1 and 5 respectively. Overall, the model fit indices we obtained all indicate an excellent fit for the measurement model. In addition, to assess the discriminant validity, this study adopted the average variance extracted (AVE) and inter-construct correlations comparison method. To achieve discriminant validity, Chin (1998) suggests that the square root of AVE for each construct should be greater than its correlations with other constructs. In our study, for all six constructs the square root of AVE is greater than their correlations with other constructs, which means that the discriminant validity is confirmed.

4.4. Moderated structural equation modelling

In order to test the theoretical model, structural equation modelling (SEM) technique was adopted. Structural Equation Models is consisting of a structural model evaluating the measurement of latent variables, while also testing relationships between latent variables (Babin, Hair, & Boles, 2008). By comparing the model and empirical data, the fit-statistics assessment is enabled to evaluate whether the assumed measurement models and structural models are supported by the data. Unlike ordinary regression analysis, SEM considers several equations simultaneously, that's being said, it can be adopted to conduct and combine a great variety of statistical procedures, e.g., multiple regression, factor analysis, (M)ANOVA and so on, thus, the technique enables us to testify direct relationships and moderator effects in the same model. Since all the variables in our study are latent, moderated structural equation modelling (MSEM) is more appropriate than moderated regression analysis. Moreover, MSEM is helpful to address the limitations of moderated regression analysis, such as the loss of statistical power as reliability decreases (Aiken & West, 1991) and estimated coefficient bias (Ping, 1995). Following Cortina, Chen, and Dunlap (2001) and Conway, Fu, Monks, Alfes, and Bailey (2016), we composed the moderated structural model through a three-step procedure. First, all the question items for the social control ($S_{xn,}$ n = [1, 4]) and formal control were standardized ($S_{zm,}$ m = [1, 5]). Then, we computed the interaction as follows:

$$(1)\ xz = \sum_{1}^{4} S_{xn} * \sum_{1}^{5} S_{zm}$$

Next, we fixed the measurement properties, including the path coefficient (λ_{xz}) and random measurement error (θ_{xz}) for interaction term xz in our structural model as follows:

$$(2)\ \lambda_{xz} = \sum_{1}^{4} \lambda_{xn} * \sum_{1}^{5} \lambda_{zm}$$

where λ_{xn} represents the path coefficients from the construct (i.e. social control) to its items S_{xn}, n = [1,4], and λ_{zm} represents the path coefficient from the latent construct formal control to its indicators S_{zm}, n = [1,5].

We calculated the random measurement error for interaction term xz as follows:

$$(3)\ \theta_{xz} = \left(\sum_{1}^{4} \lambda_{xn}\right)^2 * Var(x) * \sum_{1}^{5} \theta_{zm} + \left(\sum_{1}^{5} \lambda_{zm}\right)^2 * Var(z) * \sum_{1}^{4} \theta_{xn} + \sum_{1}^{4} \lambda_{xn} * \sum_{1}^{5} \lambda_{zm}$$

where θ_{xn} and θ_{zm} represent the random measurement errors for indicators S_{xn} and S_{zm} respectively.

5. Results and analysis

We also obtained good model fit indices for the MSEM fit (X^2/df = 1.481, CFI = 0.958, IFI = 0.959, GFI = 0.859 and RMSEA = 0.045). In H1, we hypothesized that formal control is positively associated with green product innovation. However, the result indicates that the positive impact of formal control on green product innovation is not significant ($p = .462 > 0.05$). Therefore, H1 is not supported. In H2, we predicted that social control would be positively associated with green product innovation. Interestingly, we find that the impact is negative and significant ($p < .05$). Therefore, H2 is also rejected. Then we considered whether social control and formal control function as substitutes or complements in improving green product innovation. The effect of the interaction term in our moderated structural model is both positive and significant ($\beta = 0.83$, $p < .01$). This indicates that formal control and social control mechanisms function as complements, thus supporting H3. To reinforce the findings from MSEM regarding the effect of our interaction term, we conducted a simple slope analysis to plot the interaction effect. As shown in Fig. 2, the effect of social control becomes positive when formal control is high. In other words, the formal control mechanism dampens the negative relationship between social control and green product innovation. Moreover, we find that social control strengthens the positive relationship between formal control and green product innovation. In summary, the interaction effect between formal control and social control functions as a complement in promoting green product innovation.

In H4 and H5, we hypothesized that green product innovation is positively associated with social performance and environmental performance. The positive effects of GPI on social performance ($\beta = 0.750$, $p < .01$) and environmental performance ($\beta = 0.738$, $p < .01$) are both significant. Therefore, our results support H4 and H5. Regarding the relationships among the performance variables, we hypothesize both environmental performance (H6) and social performance (H7) will have positive impacts on the financial performance. As expected, both environmental performance ($\beta = 0.234$, $p < .05$) and social performance ($\beta = 0.256$, $p < .01$) are significantly and positively associated with the financial performance.

5.1. Mediation analysis using phantom model approach

In order test H8, we used Bootstrapping method to conduct the mediation analysis (Rungtusanatham, Miller, & Boyer, 2014). In particular, the procedure of 95 percentile bias-corrected confidence intervals with 2000 samples with replacement was applied to represent the sampling distribution of the indirect effect (Cheng, Chaudhuri, & Farooq, 2016). With the Bootstrapping method, whether both direct effect and indirect effect of the independent variable on the dependent variable are significant is the key indicator of mediator's significance (Zhao et al., 2010). Our results indicate that the total effect between GPI and financial performance is 0.768 ($p < .001$), whereas both of the direct effect and the indirect effect are positive and significant at 0.001 level (Table 6). These results suggest that social performance and environmental performance jointly mediates the relationship between GPI and the financial performance. Therefore, H8 is confirmed. As shown in Fig. 1, environmental performance and social performance can be viewed as the parallel mediators for the relationship between GPI and financial performance. Therefore, the indirect effect between GPI and financial performance is actually represented by two different paths (or individual indirect effect) as follow:

Path 1: GPI ➔ Environmental Performance ➔ Financial Performance.
Path 2: GPI ➔ Social Performance ➔ Financial Performance.

According to Rungtusanatham et al. (2014), for the structural model with parallel mediators, i.e., more than one mediator in an indirect relationship, mixed conclusions may be reached. The reason behind this is that the total indirect effect does not tell the effect of a specific path. One of the constituent paths may account for the major portion of the total indirect effect. Therefore, to further examine H8, it is important to individually test the specific indirect effect (Macho & Ledermann, 2011). In this study, to examine the specific indirect effect, we adopt the phantom model approach. Specifically, the phantom model contains only those phantom variables corresponding to the variables in the parent model and direct effects that are necessary for specifying the individual indirect effect as a total effect (Macho & Ledermann, 2011; Perera, 2013). We perform the phantom model in the AMOS 24 Programme Editor. The programme code for modelling the phantom constructs in AMOS is available from the authors.

In Table 7, the estimations of the specific indirect effect and 95% CIs-based bootstrapping are provided. Again, 2000 bootstrap samples are used in the individual bootstrapping mediation analysis. The results indicate two significant specific effects for both Path 1 and Path 2, because the confidence interval for indirect effect of both Path 1 and Path 2 does not contain zero, the hypothesis of the significant

Table 6
Bootstrapping results for mediation relationship between green product innovation and financial performance through environmental and social performance.

	Standardized effects	95% Confidence interval	Two-tailed significance
Total effect	0.768	[0.678, 0.840]	0.002**
Direct effect	0.403	[0.188, 0.626]	0.001**
Indirect effect	0.365	[0.185, 0.553]	0.004**

** Significant at 0.001 level.

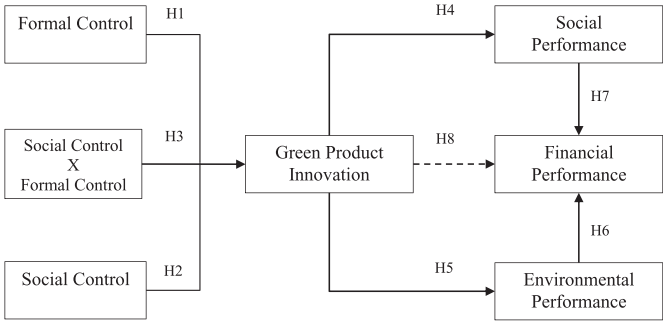

Fig. 1. Theoretical model.

Table 7
The estimated specific effects and 95% confidence intervals for testing H8.

Path	Indirect effect	Bootstrapped Standard error	95% CI based on bootstrapping	
			Lower bound	Upper bound
Path 1: GPI→EP→FP	0.201	0.085	0.060	0.408
Path 2: GPI→SP→FP	0.194	0.078	0.062	0.388

mediation effects of both environmental performance and social performance in the relationship between GPI and financial performance is further supported (*H8*). However, in terms of the magnitude of the effects, we can distinguish two individual indirect effect. That is the mediation effect of Path 1 is higher than that of Path 2.

6. Discussion

The objectives of this paper are twofold: (1) to investigate how control mechanisms act as the antecedent to influence GPI, and (2) to examine how GPI promotes firms' performance in the context of China. By pointing out the inconsistent arguments in the existing literature, we have provided a more accurate exposition as to how the interplay of social control and formal control can contribute to GPI and identified the impact of GPI on firms' social, environmental and financial performance. From the perspective of the transaction cost economics and SET, we have developed a theoretical framework to link these important concepts together.

Surprisingly, the insignificant result with regard to H1 and the negative result for H2 are not in line with our expectation, which indicates that the application of either social control or formal control in isolation cannot bring about a beneficial result for GPI. A possible explanation for this is that the legal system is still in the development stage in China, so that if firms apply only social control, by building trust and shared norms to guide suppliers' and buyers' behaviour, the lack of formal written contract will still leave space for parties to engage in opportunistic behaviours and negotiations to lower the cost or quality, which might damage the focal firm's reputation and incur penalties (Li et al., 2008). Where it is not possible to improve the relationship between parties, transaction fees might be increased (Mayer & Teece, 2008). This finding is consistent with Tachizawa et al.'s (2015) assertion that contractual monitoring is insufficient to assure a superb green supply chain management, and that collaborative approaches between buyers and suppliers should include both formal control and social control.

In addition, this study provides empirical evidence to resolve the uncertainty as to whether formal control and social control should be applied as complements or as substitutes. As illustrated in Fig. 2, our results show that the effect of the interaction term is positive and significant, which suggests that a complementary relationship between social control and formal control is more beneficial for GPI adoption than is a substitute relationship. This conclusion supports Cao and Lumineau's (2015, p.29) claim that "*contractual and relational governance tend to complement rather than substitute each other*". While some scholars have argued that formal control is a reflection of a lack of trust and might be in conflict with social control (Malhotra, 2009; Rai, Keil, Hornyak, & WüLlenweber, 2012), this is based on a misunderstanding of the strict meaning of control. In fact, control mechanisms encourage firms to implement their good intention, which means that even if there are flaws or lacunae in the explicit contract, the trust built by social control is a commitment to the mutual relationship (Malhotra & Lumineau, 2011) and drives parties to act correctly. Further evidence also indicates that implementing formal control and social control simultaneously can reduce conflict and increase satisfaction for buyers and suppliers (Cao & Lumineau, 2015). This is because, while the legal contract is built to regulate each party's behaviours, the inflexibility of some set clauses might mean that it cannot match all situations. In that case, social control can provide an alternative method to arrive at an optimal solution (Zhang et al., 2017), so that suppliers and buyers can get better GPI.

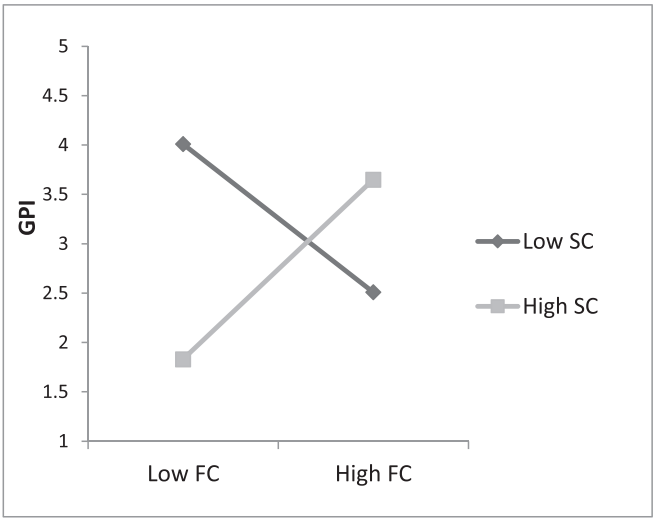

Fig. 2. Effect of the interaction term.

Our results with regard to H4 and H5 are consistent with Chen et al. (2006), who assert that the development of GPI is a key capability for competitiveness. While the potential value of implementing environmental management in the context of developing markets has been generally recognized by both academics and practitioners, this research further demonstrates the environmental and social value of GPI in the manufacturing industry. Our study provides evidence that GPI leads to improved social performance. This finding is consistent with Zailani et al.'s (2015) argument that green innovation initiatives (including product innovation and process innovation) can help to achieve better social performance. In summary, our results indicate that the adoption of GPI allows Chinese firms to improve both economic and social performance. In other words, by considering environmental issues when innovating new products, firms can maintain competitive advantage and achieve sustainable development. As expected, both environmental performance (H6) and social performance (H7) are found to be positively associated with the financial performance. The findings are consistent with the sustainability research that emphasize the importance of achieving the triple bottom line (Feng et al., 2018; Gimenez, Sierra, & Rodon, 2012; Hubbard, 2009). Importantly, this study finds that GPI has a significant and positive indirect impact on the financial performance. That is, both environmental and social performance mediate the relationship between GPI and financial performance. This finding supports Chan et al., 2016, p. 389 opinion that under the pressure of environmental regulation and social concerns, GPI benefits a firm's financial performance by increasing "*cost efficiency and firm profitability*". This result provides empirical evidence to refute the arguments that investment in green innovation would be an economic burden for firms (Ambec & Lanoie, 2008; Li, 2014) and that no relation can be found between GPI and firms' economic growth (Gilley et al., 2000). Instead, the cost of implementing GPI can be offset and even bring profitability for the firm through improving the environmental and social performance. Therefore, this research extends the body of literature on environmental management by empirically showing that GPI can positively promote triple bottom lines, and also provides a valuable perspective for understanding the role of GPI in firm performance in China.

6.1. Contribution to the literature

This study makes several contributions to the literature on control mechanisms and GPI. First, new knowledge of B2B literature has been generated in terms of the way on improving firm performance. Previous studies of B2B mainly focus the role of innovation as a key to pursuing sustainable and circular financial outcome (Spring & Araujo, 2017), or improving competitive advantage on environmental sustainability (Mariadoss, Tansuhaj, & Mouri, 2011). While despite the important role of innovation as enablers of boost performance, limited researches have studies how B2B participants can leverage different forms of innovation (Ranta, Keränen, & Aarikka-Stenroos, 2019).

The findings from this study complement existing knowledge by showing how B2B focal firms adopt two types of governances to work on how the focal firms will create environmentally-friendly value with their suppliers. In addition, TCT and SET articulate in detail how applying control mechanism in GPI can be translated into relevant financial, environmental, and social benefits in supply chain, the research also suggests that nevertheless the potentially high cost of developing GPI, that investment will benefit the firm by signalling its willingness to conform to institutional pressure and by helping it to achieve better performance.

When implementing GPI, the firm makes clear its commitment to consider both the relevant environmental laws and regulations, and the societal norms. Companies that engage in GPI recognize that disruption and damage to the environment can be minimized, or even avoided altogether, if products are designed to have zero or minimal impact. Only with a clear understanding of the importance of GPI are firms likely to adopt and implement the practice, and then benefit from it. The argument that GPI is beneficial to firm performance is supported by traditional RBV, since green product innovation explores new resources and capabilities or exploits existing knowledge that cannot be imitated by competitors, thus increasing the firm's competitive advantage (Teece, Pisano, & Shuen, 1997). That is, not only does green product innovation meet the institutional expectation for minimum pollution, but at the same time, the new technologies and knowledge used in GPI will help the firm to perform better in the market.

Secondly, our findings demonstrate the complex relationship between control mechanisms and GPI. Specifically, we differ from those studies which assume that formal control and social control each promote GPI, and that their joint effect would automatically do the same. Instead, our research is aligned with Cao and Lumineau's (2015) argument that the idea that social control and formal control each influence performance is not interchangeable with the idea that their joint implementation affects performance. Therefore, we test separately the impact of each control mechanism on GPI, and their joint impact. Most interestingly, the results show that applying only one of the control mechanisms cannot improve a firm's GPI, while using formal control and social control as complements significantly influences GPI. This finding might be explained by the fact that the Chinese legal system for environmental protection is not yet fully developed, so that legislation must be complemented by social agreement. That is, while a formal contract is necessary to regulate supplier and buyer behaviour, social control is also needed to maintain their relationship in the long term. Hence this study suggests that formal control and social control should be implemented simultaneously to facilitate better GPI.

Thirdly, this research contributes to the debate on the impact of GPI on firm performances. Previous studies have reached different conclusions on the relation between GPI and firms' financial performance (Ambec & Lanoie, 2008; Chen et al., 2006; Gilley et al., 2000; Li, 2014; Zhang & Walton, 2017), and only few researches have considered the impact of GPI on financial performance might be mediated by environmental performance and social performance. Our study suggests that while firms need to commit to extra expenditure for new green technologies and product development, the integration of environmental concerns into product innovation could help to reduce environmental harms as well as enhance social influence. Therefore, our research contributes to the debates in the green innovation and environmental management literature on the relation between GPI and performances. It provides empirical evidence on a more in-depth mechanism of how GPI influence on the financial performance.

6.2. Managerial implications

This study also provides some interesting insights for firm managers with regard to the adoption of control mechanisms for GPI. First of all, it is essential for managers to consider both formal and informal institutional requirements concerning environmental protection (Greenwood, Oliver, Suddaby, & Sahlin-Andersson, 2008; Zucker, 1983). With better understanding of the legal system and social values related to this issue, managers are more likely to engage in appropriate and meaningful behaviours. In other words, they will apply ecological concerns to their product innovation in order to comply with institutional expectations (Shu et al., 2016). By doing so, they will win a green image for their firms that will bring with it more opportunities, while also meeting stakeholders' demands on the reduction or avoidance of harm to the environment.

Furthermore, although previous studies have emphasized that control mechanisms are an important element of organizational management (Abdi & Aulakh, 2017; Huber et al., 2013; Zhang & Zhou, 2013), given that both formal governance and informal relationships play important roles in Chinese business, firms should pay attention to both formal control and social control, rather than focus on only one of them. In this paper, we argue that applying either social control or formal control in isolation does not guarantee a better GPI in China. Indeed, when social control is used without the complement of formal control, it could have a detrimental effect on GPI. One possible explanation for this is that too strong a focus on social control activities could shift attention away from the need to take action on GPI. However many meetings and discussions a company might have with other stakeholders, social control involves no written commitment, so participants might never take actual actions to comply with the agreements reached. Moreover, social activities demand both resources and time from the focal firm, especially when there is dissent among participants (Nemeth & Staw, 1989), so that the more social control it applies, the lower the application level of GPI might be. Instead, the empirical results indicate that the two types of control mechanisms should be implemented as complements rather than substitutes, and that practitioners will achieve greater benefits by putting formal control and social control into practice at the same time.

In a B2B context, it provides clear evidence to focal firm about the adoption of control mechanism and its suppliers for improving GPI, that is, managers should simultaneously formalize environmental regulations and build up relational connection, by doing so, not only can opportunism be lessened, but also cooperation and coordination between buyer and suppliers can be improved (Cao & Lumineau, 2015). If either focal firms or suppliers cannot apply control mechanisms correctly, they might not get the expected return from investing in GPI, so it is crucial that they understand the characteristics of each control mechanism and how to adopt them effectively (Zhang et al., 2017). Moreover, this research indicates that developing control mechanism is of important strategies from organizations in order to stimulate firms to contribute to environmental innovation. The practical contribution guides organizations to develop formal control and social control as complements for encouraging both focal firm and suppliers to participate in their initiative of green innovation.

Last but not least, this study offers practitioners a more in-depth explanation of the GPI-performance relationship. Our research suggests that firms can effectively incorporate a green orientation into product innovation to reap benefits in the form of improved competitiveness in the market, and better environmental, social and financial performance (Zailani et al., 2015). This might be because green-oriented firms are

inclined to develop an adhocracy culture regarding green development (Zhang & Walton, 2017), and when firms integrate an ecological concept into their product innovation they invest in developing superior resources and technologies, which then become the sustainable competitive advantage to help them develop new products with better solutions to environmental problems, which in turn will help the firms to achieve better performance.

7. Conclusion

Given the environmental impact of product innovation, organizations recognize that GPI can play an important role in firm performance. However, while the importance of GPI is widely acknowledged, few researches have investigated its drivers. In this paper, we examine the operation of a specific antecedent, control mechanisms, and how best to apply these mechanisms to improve the GPI. The absence of significant and positive results for the direct effects of either formal control or social control on GPI implies that applying only one of these cannot enhance GPI. Therefore, we further investigate the joint impact of control mechanisms on GPI, and how best to implement these mechanisms to achieve better GPI. The results of running MSEM shows that the interaction effect of formal control and social control is positive and significant, which means that adopting both mechanisms simultaneously strengthens GPI. Hence, the two control mechanisms should be implemented as complements to achieve better GPI. Moreover, in responding to the call of Berrone, Fosfuri, Gelabert, and Gomez-Mejia (2013) for more sophisticated theorizing and tests in the area of operations management, we find significant results as to the positive effects of GPI on environmental performance and social performance. Last but not least, the impact of GPI on financial performance is mediated by both environmental and social performance.

Despite the contributions to the literature and practice of control mechanisms and GPI, this research is subject to several limitations, which could provide directions for future research. First, the research suffers from a potential weakness common to quantitative studies, in that it examines the interplay of formal control and social control using cross-sectional survey data rather than longitudinal data (Jap & Ganesan, 2000; Malhotra & Lumineau, 2011; Zhang & Zhou, 2013). In the dynamic process of implementing control mechanisms, the roles and interplay of formal control and social control could change accord to different situations; however, the meta-analysis is based on the correlations between formal control and social control and cannot interpret the causal relationship between them. In order to understand the dynamic nature of the relationship between different control mechanisms, qualitative studies should be conducted, for example longitudinal research or process model building (Cao & Lumineau, 2015). Secondly, in common with the majority of studies in green management, the sample size of this research is relatively limited. Even though the result of power analysis shows that we have sufficient statistics to support the regression model, our theoretical model could be more accurately verified with a larger sample. Thirdly, our study explains why control mechanisms are important for enhancing GPI based on institutional theory; that is, control mechanisms are effective tools to ease institutional pressure by meeting the institutional requirements for GPI. However, we have not investigated how the institutional environment influences the formal-social control interplay, or how institutional pressure acts as a moderator to impact the relation between control mechanisms and GPI. Therefore, we suggest that future researches should provide empirical support for institutional theory. Fourthly, this study focuses solely on the Chinese manufacturing industry, and therefore has limited generalizability. Because different countries have different legal systems, which vary in their effectiveness, the interplay between formal control and social control will also differ (Cao & Lumineau, 2015). Therefore, we suggest that future research could examine the model in different countries to increase the generalizability. Finally, owing to limited availability of data, financial and social performance are measured according to a subjective scale. Although the measurement items we adopt have been widely tested in previous literature, future studies could improve the validity by applying a multi-informant approach.

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