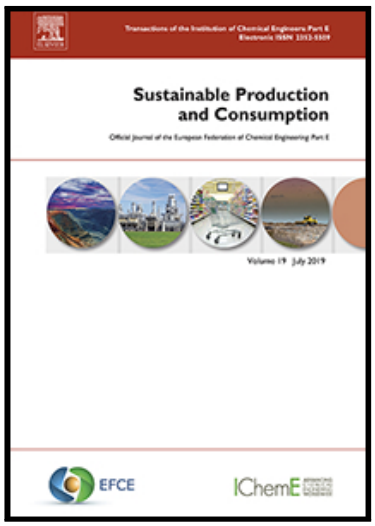

How Does Green Innovation Improve Enterprises' Competitive Advantage? The Role of Organizational Learning

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How Does Green Innovation Improve Enterprises' Competitive Advantage? The Role of Organizational Learning

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Abstract: Green innovation is an inevitable response to stringent environmental regulations as well as sustainability trends in production and consumption. Therefore, how to transform green ideas into concrete practices while enhancing competitive advantage is an urgent problem for enterprises. Adopting a knowledge-based view, this study aimed to reveal the mediating role of organizational learning in the process whereby green innovation affects enterprises' competitive advantage. This study also attempted to clarify the boundary conditions of this process using a framework that combines stakeholder theory and institutional theory. Based on a sample of 235 Chinese manufacturers, the proposed theoretical model was tested using the causal steps approach and structural equation modeling. The results indicated that green innovation was positively related to enterprises' competitive advantage, and this process was mediated by organizational learning. Furthermore, stakeholder and policy pressures both positively moderated the mediating effect of organizational learning. It is thus recommended that competitive advantage should be established based on the synergy between macrolevel green innovation strategies and microlevel organizational learning activities. In addition to acting upon stakeholders' calls for environmentally friendly production, enterprises should also positively accept policy pressures and aim to meet or exceed environmental regulations.

Keywords: green innovation; organizational learning; competitive advantage; stakeholder pressure; policy pressure

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Conflict of interest statement

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work. There is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled "How Does Green Innovation Improve Enterprises' Competitive Advantage? The Role of Organizational Learning".

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1 Introduction

In the *2020 Environmental Performance Index* issued by Yale University (2020), among 180 economic entities, China ranked well below average at 120 in terms of its environmental performance. As a result of its rapid growth–oriented development in the early stages of the "reform and opening up," China now faces increasingly severe environmental problems. The rapid-growth development mode is therefore incompatible with China's new emphasis on green, low-carbon, circular development (Marco-Fondevila et al., 2018). Enterprises are major consumers of natural and social resources. Emissions and waste produced by production and operation activities have become major sources of environmental pollution in China (MEE, 2020). Therefore, implementing green innovation strategies—which seek to integrate the green concept into a product's entire life cycle—can help enterprises reduce environmental damage and meet stringent environmental regulations. In addition, given the global trend toward green development, green innovation can help enterprises achieve "win-win" outcomes in terms of profit, social benefit, and competitive advantage, especially in emerging markets such as China (Chen et al., 2016).

Many studies have examined green innovation's effect on business competitiveness (Borsatto and Amui, 2019; Chiou et al., 2011; Yin et al., 2020) and have revealed the mechanisms of this effect, mainly adopting a resource-based view (e.g., assets, technology, capability) (Berrone et al., 2013; Schiederig et al., 2012; Sellitto et al., 2020). However, based on the work of researchers such as March (1991) and Grant (1996), a knowledge-based view (KBV) emerged that can provide further insight into the sources of sustainable competitive advantage. With the help of organizational learning, business strategies can be effectively understood, recognized, and implemented within an organization (Teece et al., 1997). Therefore, as a means of integrating resources and creating new knowledge, organizational learning is key to carrying out business strategies and achieving sustainable

competitive advantage. Yet, existing research on the various sources of competitive advantage has mainly focused on valuable, rare, inimitable, and nonsubstitutable natural resources (Akter et al., 2020) while ignoring microlevel knowledge and how it is generated (i.e., organizational learning). As such, investigating organizational learning could help answer the lingering question of how to implement green innovation strategies and thus make the transition from slogans, strategies, and plans into actual performance. Therefore, adopting KBV and integrating stakeholder theory and institutional theory, this study examined the mediating role of organizational learning in the effect of green innovation on enterprises' competitive advantage. It also investigated the potential moderating effects of increasingly stringent business constraints (i.e., stakeholder pressure and policy pressure).

Examining the functional routes and boundary conditions of the relationship between green innovation and enterprises' competitive advantage can have both theoretical and practical implications for simultaneously improving profits and environmental performance. Knowledge is a fundamental competitive resource that is difficult to obtain through the market, but it can be created through organizational learning. Our discussion of organizational learning can help enterprises gain the ever-changing Ricardian rent and build dynamic defense barriers (Caves and Porter, 1977), thus effectively responding to the challenges brought by the green development trend and establishing sustainable competitive advantage. Furthermore, in China, sustainable environmental management is now a basic requirement for the long-term development of modern enterprises, forcing businesses to shift toward an innovation-driven mode of operation. In this regard, organizational learning, which aims to acquire, create, integrate, utilize, and share knowledge, may be conducive to building a dynamic and sustainable environmental management system. Shifting from passive environmental responses to proactive environmental management can coordinate diverse stakeholder interests and consolidate the sustainable competitive advantage of enterprises.

2 Literature review

2.1 Green innovation

Business models and patterns of market competition have changed dramatically as a result of increasingly strict environmental regulations and stakeholder pressure. The traditional end-of-pipe governance of waste cannot meet current requirements for ecological protection or help enterprises enhance their competitiveness (Triebswetter and Wackerbauer, 2008). Porter and van der Linde (1995) suggested that enterprises will only obtain advantages when the green idea is implemented throughout the entire product life cycle. Researchers have explained green innovation from different perspectives (e.g., products, technologies, processes, consequences), focusing on distinct factors (e.g., performance measures, implementation initiative, double externalities) (Kesidou and Demirel, 2012; Franceschini and Pansera, 2015; Zhang and Zhu, 2019). That said, the definition of green innovation proposed by Chen et al. (2006)—which emphasizes the macrolevel guiding role of business strategy—has been widely accepted. Specifically, green innovation refers to green-driven innovation involving all aspects of knowledge, technology, products, procedures, and systems under the umbrella of sustainable development, which can help enterprises build differentiated competitive advantage (Schiederig et al., 2012). Along these lines, the present study aimed to explore the effect of proactive green innovation strategy on overall competitiveness, with a focus on self-capability and comparative advantage.

Since 2006, research on green innovation has aligned with the global trend toward environmental governance (Karakaya et al., 2014). In China, ecological disasters such as severe haze pollution, cyanobacteria in Taihu Lake, and water pollution in Songhua River have had serious adverse effects on residents as well as economic development. Accordingly, there is consensus regarding the urgency and significance of green innovation. For example, Lanoie et al. (2011), from the perspective of environmental economics, investigated the effect

of environmental regulations on enterprise competitiveness as well as the influence of various regulatory tools on green innovation behavior. Focusing on innovation, Ghisetti and Rennings (2014) identified the driving factors of green innovation, noting that market demand, technological change, and policy are the important prerequisites for green innovation. Strategic management research has also investigated the effects and mechanisms of green innovation in relation to competitive advantage. Such work has focused on the effects of internal factors (e.g., resources, capabilities) on green innovation performance (Du et al., 2018; Ma et al., 2018) as well as green innovation's effect on corporate economic performance (Roud and Thurner, 2018). Meanwhile, industrial organization theory has been used to examine the interactive relationships between market structures and green innovation behavior (Fernando and Wah, 2017; Stucki et al., 2018), especially the effect of green practices by industry leaders on the formation of green strategies among small and medium-sized enterprises (Wakeford et al., 2017). In summary, many studies have found that proactive, sustainable green innovation can improve production efficiency and foster a green image for companies, thus improving their competitive advantage.

2.2 Enterprises' competitive advantage

Competitive advantage means an enterprise gains more profits or benefits than its competitors in terms of cost, technology, brand, management, and so on (Barney, 1991). Existing studies have mainly adopted a resource-based view to explain green innovation's effect on enterprises' competitive advantage. It has been suggested that differences in competitive advantage stem from the valuable, rare, inimitable, and nonsubstitutable resources of green innovation practices, including material resources (e.g., financial subsidies for new-energy vehicle manufacturers), featured products (e.g., desulfurization equipment), and supporting systems (e.g., management systems) (de Guimarães et al., 2018; Ndofor et al., 2011). Chen (2008) found that green intellectual capital positively affected enterprises'

competitive advantage. In the context of emerging economies, Saranga et al. (2018) found that product development ability, as an essential component of strategy, was closely related to competitive advantage in multiple dimensions. Importantly, simply possessing resources does not mean they are efficiently utilized or that competitive advantage is obtained. This is indirectly supported by Singjai et al. (2018), who studied green innovation reform in Thailand's hotel industry. They found that the influence of green innovation strategy was often not direct or observable; strategic objectives and content needed to be executed through knowledge-integration activities (e.g., learning). From this perspective, competitive advantage will only be obtained when specific and effective environmental management actions are formed and implemented. Therefore, enterprises must efficiently integrate internal and external resources through organizational learning and incorporate the idea of green development into the entire product life cycle. This will ensure the thorough implementation of green innovation strategy, which in turn will positively affect competitive advantage.

2.3 Organizational learning

KBV positions an enterprise as an organization for acquiring, processing, and using knowledge (Easterby-Smith et al., 2000; Grant, 1996). KBV holds that knowledge is an essential asset, and organizational learning is crucial for exploring new knowledge and establishing competitive advantage (Valentim et al., 2016). Organizational learning refers to the social interaction process in which new knowledge is constantly generated, interpreted, integrated, and institutionalized at multiple levels (e.g., individuals, teams, organizations) to meet an enterprise's targets or adapt to changes in the environment. Organizational learning is generally regarded as preparation for organizational change. Meanwhile, its role in integrating existing knowledge and refining macrolevel strategies has also been highlighted. As proposed by March (1991), learning is usually classified as either exploitative or exploratory. Exploitation is oriented toward reducing variation, maintaining stability, and

pursuing efficiency; exploration, meanwhile, is oriented toward experimentation and transformation. Exploitative learning involves an in-depth exploration of existing knowledge, which can refine overall strategic planning into specific tasks that can be performed by specific departments and enhance employees' understanding of organizational strategy. By contrast, exploratory learning aims to promote the absorption and transformation of new knowledge and ideas while enhancing responses to market demand and policy regulations, thereby contributing to the implementation of transformational innovations, such as green innovation (Hotho et al., 2015). Therefore, incorporating organizational learning into research on green innovation's effect on enterprises' competitive advantage can help refine the internal transmission process, which has generally been overlooked in prior research.

2.4 Hypothesis development

2.4.1 Green innovation and enterprises' competitive advantage

In the knowledge economy, the key to gaining competitive advantage has shifted from material production factors to core innovation abilities. The essence of innovation is to continually pursue and efficiently apply new knowledge during the whole process of production and operation to create advantages in efficiency. Chen et al. (2006) suggested that green innovation requires creating new, environmentally friendly technologies and knowledge and then implementing them in all of the links of the product or service life cycle. By taking the lead in replacing traditional high-pollution production modes with advanced environmental-protection technologies, enterprises can reduce resource consumption and emissions. Therefore, in the resource-based view, green innovation technologies are conducive to conserving production factors, reducing operating costs, and accumulating circulation capital. Meanwhile, improving resource utilization efficiency means investing more in developing new technologies and knowledge, which helps meet the expectations of the market and stakeholders regarding sustainable, technology-intensive,

knowledge-intensive development. Thus, by utilizing unique physical and cognitive resources, green innovation helps to create and consolidate an enterprise's competitive advantage with regard to self-capability and comparative advantage (Chen and Chang, 2013).

Past studies have noted the positive role that green innovation may play in boosting competitive advantage. Drawing on the push-and-pull mechanism for eco-innovation, Kemp (2010) found that enterprises that implemented green innovation could gain product premiums to offset environmental governance costs. As a proactive response to the green consumption trend, green innovation signals an enterprise's attention to social responsibility and consumer demand; it is this concern for stakeholders that helps to maintain or improve market reputation. Thus, based on first-mover advantage and legality advantage, an enterprise can achieve a "win-win" situation of economic and social benefit via green innovation. Furthermore, adopting a general resource-based view, Ghisetti and Rennings (2014) emphasized that green innovation can help establish an "isolation barrier." Such a barrier is based on core competencies that are difficult to imitate or transfer, such that the enterprise can continually enhance its abilities for long-term development. Even state-owned enterprises (SOEs), which are generally considered insensitive to innovation, might invest more resources into eco-innovation. Studying Russian manufacturing firms, Roud and Thurner (2018) found that SOEs could exceed environmental regulation requirements and gain more competition resources by implementing green innovation. Overall, green innovation not only contributes to accumulating capital, technology, knowledge, and other resources but also facilitates adaptation to increasingly strict regulations and the global shift toward sustainable practices. Improved self-capability and comparative advantage jointly enhance enterprises' competitive advantage. Based on the above, the first hypothesis is proposed:

Hypothesis 1: Green innovation is positively associated with enterprises' competitive advantage.

2.4.2 Mediating role of organizational learning

Resource-based theory has articulated the advantages of green innovation for accumulating physical and cognitive resources. However, possessing resources does not necessarily mean efficient utilization, especially for nonmaterial resources such as knowledge. At the same time, how to refine abstract strategies into concrete practices is also an urgent problem faced by enterprises. KBV holds that the core task of an enterprise is to acquire, integrate, and use knowledge. Knowledge is an essential resource in market competition. Thus, as the primary means of knowledge mining and development (Mueller et al., 2012), organizational learning directly affects business strategy implementation and the benefits of innovation activities (Gerschewski et al., 2015), which ultimately affect competitiveness.

High-risk green innovation must be complemented by in-depth organizational learning. Based on the classifications of exploitative and exploratory learning (March, 1991), we propose that exploitation aims to make full use of existing technologies and expertise to rapidly respond to changes in the business environment at a minimal cost (Popova-Nowak and Cseh, 2015). Exploitative learning can also update existing knowledge while maintaining some degree of organizational routine, which improves employees' recognition of newly proposed strategies. Exploitative learning integrates green ideas into production or service processes in an appropriate way (rather than impulsively or abruptly) and helps refine the overall strategy into specific goals. Thus, it not only facilitates the execution of strategy but also mitigates resistance from traditional enterprises (e.g., heavy-industry companies). In addition, the essence of green innovation is to move beyond the traditional growth-focused business model, which comes at the cost of the environment. In this regard, the greater the resistance to green innovation, the more necessary it is to apply exploratory learning to transform existing processes. Exploratory learning facilitates the exchange of environmental technologies, expertise, and nonsubstitutable resources between organizations. This fusion of

heterogeneous information can enhance the success of environmentally friendly product development and reduce the risks of green innovation (Yalcinkaya et al., 2007). Therefore, green innovation needs organizational learning to mitigate its potential conflicts with existing business models and integrate the heterogeneous knowledge needed for innovation. Organizational learning is thus a major prerequisite for green innovation success.

Strategy-oriented organizational learning is a higher-order learning process in which enterprises internalize exploitative and exploratory knowledge to improve their understanding and execution of strategies (Salonen et al., 2018). Organizational learning for green innovation enables enterprises to update their core competencies and move beyond existing development paths. By introducing green thinking into the existing knowledge-management mode, organizational learning can deal with the challenges of green innovation in terms of capacity, efficiency, and effectiveness (Vidal-Salazar et al., 2012). Comparatively studying start-up and established enterprises, Currie et al. (2012) found that organizational learning enhanced internal resource management for both types of enterprises via normative learning and knowledge sharing. Such a management mode, based on heterogeneous knowledge, can foster sustainable competitive advantage. Relatedly, from the perspective of organizational boundaries, Kang (2015) suggested that an open attitude or a strong intention to learn can free an enterprise from the straitjacket of physical boundaries. Actively conducting strategic interactions and knowledge sharing with external subjects can help enterprises establish close partnerships, which can improve both operational performance and competitive advantage. Furthermore, organizational learning at different levels within an enterprise helps green thinking become ubiquitous among employees. Then, employees internalize, express, externalize, and combine green innovation knowledge (Nonaka, 1994), which enhances employees' recognition of green innovation strategies and coordinates green innovation practices. Therefore, based on KBV, we propose that organizational learning coordinates

various knowledge-management activities at different levels, of different types, and among different organizations, laying a solid foundation for implementing strategic planning and forming competitive advantage.

In summary, we propose that through the discovery, invention, acquisition, selection, promotion, reflection, and output of new knowledge, organizational learning establishes a rich knowledge base, which is a prerequisite for the formulation and implementation of business strategy. The exploitative learning embedded in the existing knowledge management mode improves employees' recognition of green innovation. Meanwhile, exploratory learning breaks through the constraints of physical organizational boundaries and brings together heterogeneous resources. Such knowledge fusion helps enterprises accurately grasp new trends in green development. Improving existing technologies and standards can produce sustainable competitive advantage for long-term development. Based on the above, the second hypothesis is proposed:

Hypothesis 2: Organizational learning mediates the relationship between green innovation and enterprises' competitive advantage.

2.4.3 Moderating effects of stakeholder pressure and policy pressure

Businesses, like people, are fixed within their social structures. Operating practices such as sustainable production, organizational learning, and green supply chains are bound to be subject to external influence. Studying the driving factors of corporate social responsibility (CSR) strategies, Lee (2011) found that institutional and stakeholder pressures gave rise to different social behaviors among enterprises. Karassin and Bar-Haim (2016), focusing on the tightening of environmental regulation, also found that corporate strategies were mainly influenced by stakeholders (e.g., consumers and local communities) and institutions (e.g., laws and regulations). The present study adopted this division of stakeholders and institutions.

Stakeholders are individuals or groups who can influence organizational behavior and the achievement of organizational goals or are affected by the process of achieving organizational goals (Freeman, 1984; Lee, 2011). Enterprises traditionally uphold the principle of shareholder primacy and regard economic benefit as the main goal of business. However, according to stakeholder theory, an organization's survival and success depend on the extent to which it meets stakeholders' needs and expectations and creates value (Rhee et al., 2018). An organization thus needs to balance the diverse interests of different stakeholders as opposed to merely focusing on increasing shareholder wealth. With regard to environmental protection issues that involve the public interest, maximizing social performance needs to be a core objective of business strategy. Focusing on green supply chain management, Zhu et al. (2013) noted that, in contrast to the coercive pressure of environmental regulation, normative and mimetic pressures from stakeholders (e.g., customers, competitors, communities, shareholders) are often more likely to stimulate internal and proactive green practices. With enhanced environmental awareness, consumers increasingly demand that enterprises incorporate green innovation and are resistant to traditional high-polluting production (Rexhäuser and Rammer, 2014). Close monitoring by environmental groups and the media also spurs enterprises to implement green innovation, which increases the need to enhance employees' recognition of green innovation through organizational learning. Furthermore, the global "green revolution" has forced shareholders to proactively seek out green innovation and establish a green image (Parmar et al., 2010). Despite the large transformation costs and potentially poor financial performance in the short term, we propose that enterprises are motivated to carry out effective organizational learning activities to ensure successful green innovation and long-term development. Finally, even if an enterprise does not try to invest more in green innovation than its competitors, pressures related to legitimacy and norms will prompt the enterprise to passively adopt green practices.

Therefore, the inclusion of different stakeholders in organizational decision-making is not only an ethical requirement but also a strategic prerequisite. Stakeholder pressure encourages enterprises to proactively carry out green innovation and further implement this high-risk strategy with the aid of organizational learning. Based on the above, the third hypothesis is proposed:

Hypothesis 3: Stakeholder pressure moderates the effect of green innovation on organizational learning, such that the relationship is strengthened when stakeholder pressure is high.

Institutional theory emphasizes integrating normative values or coercive constraints into an organization's structure and activities, which maintains consistency between organizational behavior and the external institutional environment (DiMaggio and Powell, 1983). Organizations gain legitimacy by following the dominant practices in the organization's field. Scott's (1995) three-dimensional classification of institutional pressures (i.e., coercive, mimetic, normative) is widely adopted. A growing body of literature, however, has suggested that in emerging economies, the effect of policy (representing coercive pressure) is greater than that of the other two mechanisms (Berrone et al., 2013). Coercive policy pressure is considered the main driving factor contributing to institutional isomorphism. Environmental regulations have become stricter around the world. In recent years, China's efforts to promote ecological civilization have placed enormous pressure on high-polluting enterprises, especially manufacturers (Rubashkina et al., 2015). Enterprises must incorporate green innovation into the entire product life cycle to adapt to market changes and avoid penalties (e.g., fines, trade restrictions, business suspension). Additionally, environmental standards for international trade are constantly increasing (Roy, 2017). Enterprises, with the aid of comprehensive organizational learning and innovative learning strategies, must therefore develop new knowledge and technologies to enhance their green

identity and expand their global market share. It can be seen that coercive environmental policies force enterprises to implement green innovation in terms of technologies, products, processes, and so on. Meanwhile, clear waste-emission standards and resource-saving targets also urge enterprises to shift from abstract strategic calls toward enforceable practices. In light of this, attention should be paid to the effects of organizational learning on refining macrolevel planning, improving identification with green innovation, and integrating internal and external resources. Updating existing expertise and technologies through exploitative learning and integrating heterogeneous external resources via exploratory learning can help improve green innovation performance. Based on the above, the fourth hypothesis is proposed:

Hypothesis 4: Policy pressure moderates the effect of green innovation on organizational learning, such that the relationship is strengthened when stakeholder pressure is high.

2.4.4 Moderated mediating effect

Above, we discussed the mediating role of organizational learning and the moderating effects of pressures from stakeholders and policies. Based on Edwards and Lambert's (2007) moderated mediation model, we further propose that stakeholder pressure and policy pressure will moderate the mediating effect of organizational learning on the relationship between green innovation and enterprises' competitive advantage. Specifically, the greater the pressure from stakeholders, the more enterprises need to balance the interests of multiple parties. Under normative and mimetic pressures for sustainable production, enterprises need to implement green innovation strategies in an all-around effective way. They are thus motivated to undertake diverse organizational learning activities. Organizational learning at different levels, from different organizations, and with different characteristics produces rich heterogeneous knowledge, helping enterprises make the most of existing resources and take

the lead in green innovation. Maintaining a good balance between low risk (based on exploitative learning) and high returns (based on exploratory learning) ultimately creates and consolidates competitive advantage. Therefore, we propose the following:

Hypothesis 5: Stakeholder pressure moderates the mediating effect of organizational learning on the relationship between green innovation and enterprises' competitive advantage, such that the effect is stronger when stakeholder pressure is high than when it is low.

Policy pressure from laws and regulations also moderates the mediating effect of organizational learning. The greater the policy pressure, the more willing enterprises are to proactively implement green innovation to avoid punishment. Furthermore, in China, environmental tax rebates, low-interest loans, technical support, and other environmental policies are becoming increasingly generous. Hence, enterprises increasingly have the resources needed for green transformation and upgrading. Then, organizational learning has a more positive influence on the relationship between green innovation and competitive advantage. Conversely, when policy pressure is low, calls for green innovation from top management might not be smoothly put into practice, and organizational learning and competitive advantage are reduced accordingly. Therefore, we propose the following:

Hypothesis 6: Policy pressure moderates the mediating effect of organizational learning on the relationship between green innovation and enterprises' competitive advantage, such that the effect is stronger when policy pressure is high than when it is low.

Figure 1 displays the theoretical framework of this study. We argue that when the levels of stakeholder pressure and policy pressure are high, green innovation will be more likely to stimulate organizational learning and eventually enhance enterprises' competitive advantage.

Insert Figure 1 about here

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3 Methods

3.1 Questionnaire design and sample selection

Manufacturing enterprises are the backbone of China's economy as well as the major source of environmental pollution (Li & Lin, 2016). In recent years, manufacturers have proactively pursued green and innovative development under the guidance of green production and consumption trends. Accordingly, we selected as research objects manufacturing enterprises that face stringent environmental regulations and stakeholder pressure and are therefore accelerating the pace of green transformation and upgrading. The initial 320 sample enterprises included plastic product manufacturers, petrochemical plants, paper mills, textile companies, lead-acid battery manufacturers, and other heavy polluters. These enterprises cover the Yangtze River Delta, Pearl River Delta, northeast industrial zone, and central and western regions of China. This ensured the representativeness of the questionnaire data.

The investigation was divided into two stages: preliminary interview and formal survey. Preliminary interviews were conducted in the Nanjing economic development zone and chemical industry park. Structured interviews were conducted with a total of four middle and senior managers from the petroleum, chemical, and pharmaceutical industries They included two department heads of an SOE, one deputy manager of an SOE, and one R&D director of a listed private firm. Subsequently, we discussed the questionnaire content based on the interviews and made sufficient modifications with reference to the mature literature. An outside expert was invited to check and polish the item expression, resulting in the final questionnaire. To reduce interference from selection bias and social desirability, and thus ensure data quality, we emphasized the noncommercial nature of the study in the survey. Also, the survey was conducted anonymously to alleviate respondents' privacy concerns. All of the questionnaires were distributed and collected by paper or e-mail; they included detailed

instructions to ensure the validity of the data.

Using the multiple-informant technique, company employees and executive managers received different questionnaires, such that we were able to collect and match different respondents' assessments of the green innovation effect. This helped reduce the homology bias caused by a single informant filling out a complete set of questionnaires. Each set of matched questionnaires was limited to no more than 20 respondents. Before the formal survey began, one executive questionnaire and 19 employee questionnaires were combined into a set and assigned a uniform number. The formal survey was conducted in three phases. In phase 1, we issued questionnaires covering green innovation and external pressure (including stakeholder pressure and policy pressure) to the executive managers of 320 companies. Some demographic information (e.g., business ownership, employee number, annual sales, age of company) was obtained from the human resources departments of the companies. After screening and eliminating questionnaires that lacked data or showed obvious regularity in the answers, 287 valid questionnaires were obtained. Phase 2 was conducted two months after phase 1. We distributed organizational learning questionnaires with matched and unique numbers to employees of the companies whose executives had validly completed the phase 1 surveys. To get a complete picture of organizational learning across all parts of the company, we distributed the questionnaires to employees engaged in different jobs (e.g., department directors, professional technicians, scientific researchers). When more than half of the questionnaires for a target company showed problems such as missing data or obvious regularity, we assumed the remaining questionnaires could not effectively reflect the real situation and needed to be deleted. Finally, 235 sets of valid questionnaires were obtained at the firm level. Phase 3 was conducted two months after phase 2. We issued competitive advantage questionnaires to executive managers whose companies had validly completed the second survey. After processing and screening, none of the

questionnaires returned in phase 3 were found to have problems such as missing data. As a result, the survey resulted in 235 valid sets of matched questionnaires.

Table 1 shows statistics for the key characteristics of the valid matched questionnaires. In terms of ownership, the enterprises included SOEs and their holding firms, private firms, and wholly foreign-owned firms or Sino–foreign joint ventures. Over 85% of the enterprises had been continuously operating for more than nine years. Meanwhile, the firm sizes were small (less than 300 employees), medium (300–800 employees), and large (more than 800 employees). Enterprises with an annual turnover of more than 80 million yuan accounted for 87.23%. These characteristics ensured the credibility and universality of the questionnaire data. In addition, the respondents held different positions and included executives (e.g., chairman, CEO, general manager), department heads (e.g., procurement, production, operations), technical personnel, and researchers. This effectively reduced the problem of selection bias.

Insert Table 1 about here

3.2 Measures

The scales used in this study were all derived from mature literature. To ensure the validity of the scales in the Chinese context, this study followed the standard translation/back-translation procedure. We then communicated with domain experts and entrepreneurs regarding the setting and expression of the measurement items to ensure the questionnaire content aligned with the real situation in Chinese enterprises, was clearly articulated, and was easy to understand. A seven-point Likert scale was used for measurement (1: strongly disagree to 7: strongly agree). The measured variables were set to the firm level. Executive managers and employees evaluated the overall status of the focal enterprise. Table 2 summarizes the measurement items.

Insert Table 2 about here

Green innovation. Studying China's high-polluting manufacturers, Chen et al. (2006) divided green innovation into two dimensions: green product innovation and green process innovation. Their four-item measures of green product innovation, in the three aspects of reducing pollution, saving raw materials, and recycling, are widely adopted. We followed their approach. A sample item is "The company chooses green and environmentally friendly materials in the product-design stage." However, the measures of green process innovation in Chen et al. (2006) were inconsistent with our research content because of the neglect of the external environment. Eiadat et al. (2008) suggested that green innovation throughout a product's life cycle must take into account the guiding role of environmental policy. Therefore, the present study modified the four-item scale of green process innovation by Chen et al. (2006) and focused on the effect of market consumption trends and environmental policies on the whole green innovation process. Sample items included "The company pursues the coordinated growth of economic and environmental benefits," and "The company improves production processes in a timely way according to consumers' demand for environmental protection" ($\alpha = 0.82$).

Organizational learning. March's (1991) classification of exploitative learning and exploratory learning is widely adopted. Prior studies have proposed various operations for the two types of learning, with a focus on exploring new possibilities and exploiting old certainties. However, exploitation and exploration must conduct in-depth learning regarding existing capabilities, resources, technologies, and processes based on the developed strategies (He and Wong, 2004). Therefore, the organizational learning practices required by firms with different ownership types and diverse strategies are not the same. Based on He and Wong's (2004) three-dimensional scale (including products, technologies, and the market), and combined with the characteristics of interactions between Chinese enterprises as explained by

Atuahene-Gima and Murray (2007), this study developed five questions to measure organizational learning. Since enterprise staff responded to the organizational learning scale, this study utilized Rwg(j), ICC(1), and ICC(2) to determine whether the scores met the aggregation criteria before aggregating them to the firm level. Statistical tests revealed mean values of Rwg(j) = 0.87, ICC(1) = 0.18, and ICC(2) = 0.72, which were above the standard values of 0.7, 0.1, and 0.7, respectively. It was therefore appropriate to aggregate this scale to the firm level. We used the average score of each employee to indicate the level of organizational learning in his or her enterprise. Sample items included "The company makes full use of existing technologies and resources," and "The company actively carries out exchange and cooperation with other organizations" ($\alpha = 0.76$).

Enterprises' competitive advantage. This study had the same research background as Chen and Chang (2013). Thus, we used their 11-item scale in the preliminary survey. However, feedback from the structured interviews indicated that these measures were not entirely applicable to modern Chinese enterprises. For example, heavy-industry manufacturers such as oil smelting usually did not pursue rapid growth or take the lead in launching new cleaning products due to their oligopolistic nature. Therefore, we streamlined Chen and Chang's (2013) measures from the self-capability and comparative advantage dimensions. Sample items included "The company is able to respond quickly to changes in market demand," and "The company has a good reputation in the market" ($\alpha = 0.84$).

Stakeholder pressure and policy pressure. To obtain legitimacy, businesses need to meet the needs and expectations of consumers and other stakeholders. Meeting or exceeding the requirements of laws and regulations for sustainable production can help avoid penalties. We drew on the three kinds of pressures (i.e., coercive, normative, mimetic) in Zhu et al. (2013) and further integrated pressures, except for institutional pressure, into stakeholder pressure; these pressures mainly come from customers, competitors, shareholders, and residents. A

sample item for stakeholder pressure is "Consumers propose environmental requirements for packaging and production technology" ($\alpha = 0.83$). A sample item for policy pressure is "Violation of relevant environmental regulations will be severely punished" ($\alpha = 0.77$).

Firm size influences the restriction effect of the external environment on business operations. Different types of ownership might also affect how much attention enterprises pay to green innovation. These characteristics will have a significant effect on enterprises' competitive advantage (Panwar et al., 2016). As a result, we selected firm size and ownership type as control variables. The dummy processing of control variables was conducted. The firm-size variable was measured by the number of employees; 1: less than 300 employees, 2: 300–800 employees, and 3: more than 800 employees. The ownership-type variable was divided into two categories; 0: non-SOE, and 1: SOEs and their holding firms.

4 Results and discussion

4.1 Common-method bias test

We used the multiple-informant technique to measure the variables, which overcomes the common-method bias problem to some extent. However, the same executive manager responded to items regarding green innovation, enterprises' competitive advantage, and stakeholder and policy pressure. We used Harman's one-factor approach to check for homology bias. The principal component factor analysis indicated there were five factors with the characteristic root being higher than 1 under no rotation. The interpretation variance of the first construct accounted for 30.17%, which is lower than the standard value of 50% and does not exceed half of the total variance of 71.83%. Thus, most variations cannot be explained by a single factor, which eliminates concerns regarding common-method bias.

4.2 Confirmatory factor analysis

To test the convergent and discriminant validity of each variable, we conducted confirmatory factor analysis on the 235 sets of matched questionnaires. The results showed

that all factor loadings of the five constructs passed the 5% significance test, and there was no inappropriate solution. The proposed five-factor model therefore had good convergent validity. Meanwhile, as shown in Table 3, the baseline five-factor model fit the data better than alternative models that included four-, three-, two-, or single-factor structures (χ^2/df=2.69, CFI=0.92, TLI=0.91, RMSEA=0.08, SRMR=0.06). This indicates that the five constructs measured in this study had relatively good discriminant validity.

Insert Table 3 about here

4.3 Descriptive statistics

Table 4 provides the descriptive statistics and Pearson's correlation coefficients of the variables. The results show that green innovation was positively correlated with organizational learning (β=0.19, p<0.01) and enterprises' competitive advantage (β=0.28, p<0.01). Furthermore, organizational learning was also positively associated with enterprises' competitive advantage (β=0.35, p<0.001). Pearson's correlation coefficients conformed to theoretical expectations, thus preliminarily verifying the hypotheses.

Insert Table 4 about here

4.4 Regression analysis

Hypothesis 2 was proposed to assess the mediating effect of organizational learning on the relationship between green innovation and enterprises' competitive advantage. Referring to the causal steps approach proposed by Baron and Kenny (1986), we used a set of four steps to verify the mediating role of organizational learning. First, we conducted a regression analysis of the explanatory variable (i.e., green innovation) to the explained variable (i.e., enterprises' competitive advantage). Second, a regression analysis of the explanatory variable to the hypothesized mediator (i.e., organizational learning) was conducted. Third, we conducted a regression analysis of the hypothesized mediator to the explained variable.

Lastly, a regression analysis of the explanatory variable and hypothesized mediator to the explained variable was conducted. It was required that the correlation coefficient of the explanatory variable in that step had to be lower than that in the first step. According to Model 5 in Table 5, green innovation positively influenced enterprises' competitive advantage (β=0.280, p<0.001). The first condition corresponding to Step 1 was satisfied. Then, Model 1 indicated that green innovation was positively related to organizational learning (β=0.184, p<0.01), thereby satisfying the second condition. In Model 7 in Table 5, the positive relationship between green innovation and enterprises' competitive advantage was weakened (0.280>0.223) when the mediator—organizational learning, which is significantly related to enterprises' competitive advantage (β=0.308, p<0.001)—was added to the model. Hence, conditions 3 and 4 were met as well. Taken together, green innovation was found to be positively related to enterprises' competitive advantage, thus supporting Hypothesis 1. Moreover, organizational learning played a partial mediating role in green innovation's influence on enterprises' competitive advantage. Hypothesis 2 is thus supported.

Insert Table 5 about here

Hypotheses 3 and 4 proposed that stakeholder pressure and policy pressure would positively moderate the relationship between green innovation and organizational learning. As shown in Model 2 in Table 5, the interaction term between green innovation and stakeholder pressure had positive effects on organizational learning (β=0.138, p<0.05), and the interaction term between green innovation and policy pressure was also positively related to organizational learning (β=0.144, p<0.05). To illustrate the moderating effects of the two interactions, we plotted the simple slopes for the relationship between green innovation and organizational learning at one standard deviation above and below the mean value of stakeholder pressure (Figure 2) and policy pressure (Figure 3). It is easy to see that compared to stakeholder pressure, policy pressure more positively moderated the positive relationship

between green innovation and organizational learning, which manifests as a steeper slope. Furthermore, despite the nonsignificant moderation under low-level stakeholder pressure (β=0.022, t=0.259, ns) or low policy pressure (β=0.015, t=0.166, ns), high-level stakeholder pressure (β=0.279, t=3.470, p<0.001) and policy pressure (β=0.290, t=3.563, p<0.001) both significantly moderated the relationship between green innovation and organizational learning. In summary, we found that stakeholder pressure and policy pressure both had a moderating role in the process of green innovation facilitating organizational learning, thus supporting Hypotheses 3 and 4.

Insert Figure 2 about here

Insert Figure 3 about here

Hypotheses 5 and 6 were intended to test whether stakeholder and policy pressure moderated the mediating effect of organizational learning in the relationship between green innovation and enterprises' competitive advantage. Following the moderated path method of Edwards and Lambert (2007), moderated mediation was tested using bootstrapped confidence intervals. To present the moderated mediation results in detail, we constructed the following two equations: $M=\alpha 0+\alpha 1X+\alpha 2Z+\alpha 3X\times Z$ (Eq. 1) and $Y=\beta 0+\beta 1X+\beta 2M$ (Eq. 2), where X, Y, M, and Z denote, respectively, the explanatory (green innovation), explained (enterprises' competitive advantage), mediating (organizational learning), and moderating (stakeholder pressure and policy pressure) variables. Eq. 1 was used to solve the first-stage effect of our moderated mediation model, and Eq. 2 was used to quantify the second-stage effect and direct effects. As shown in Table 6, the indirect effect of green innovation on enterprises' competitive advantage through organizational learning was greater when stakeholder pressure was high (β=0.089, p<0.05) than when it was low (β=0.007, ns). Moreover, the intergroup difference values of the first stage and the indirect effect both passed the significance test.

Thus, stakeholder pressure positively moderated the mediating effect of organizational learning in the relationship between green innovation and enterprises' competitive advantage, thus supporting Hypothesis 5. Similarly, Table 6 reports that under the condition of low policy pressure, the first-stage moderating effect was nonsignificant, and the indirect effect on enterprises' competitive advantage was also nonsignificant. Under the condition of high policy pressure, the moderating and indirect effects were both significant. Hence, the moderating effect in the first stage worked only when policy pressure was intense, and the indirect effect of green innovation on enterprises' competitive advantage through organizational learning was further moderated by policy pressure. Therefore, Hypothesis 6 is supported.

Insert Table 6 about here

4.5 Structural equation model (SEM)

To investigate the reciprocal relationships among variables, we used SEM to reveal the latent functional routes of their interactions. Regarding fitting indexes, χ^2/df = 2.141, GFI=0.918, NFI = 0.921, CFI = 0.925, and RMESA = 0.063. All conform to the corresponding standards, indicating an adequate model fit for the SEM.

Table 7 shows the functional routes among variables and the coefficients. The path coefficient between green innovation and enterprises' competitive advantage was 0.261 and passed the significance test (p<0.01), indicating that green innovation had a positive effect on enterprises' competitive advantage. Thus, the greater the investment in green innovation strategy, the more competitive enterprises will become, thereby validating Hypothesis 1. Meanwhile, the path coefficients of green innovation influencing organizational learning and organizational learning influencing enterprises' competitive advantage were 0.205 (p<0.01) and 0.293 (p<0.001), respectively. This indicates that green innovation facilitated

organizational learning activities, which in turn positively affected enterprises' competitive advantage. Hence, organizational learning mediated the indirect relationship between green innovation and enterprises' competitive advantage, supporting Hypothesis 2. In addition, the path coefficients of stakeholder pressure influencing green innovation, organizational learning, and enterprises' competitive advantage were 0.127, 0.184, and 0.125, respectively. All of the significance levels met the statistical standards. Thus, green innovation's effect on enterprises' competitive advantage was positively moderated by stakeholder pressure. The higher the level of stakeholder pressure, the greater the facilitating effects of green innovation strategies on organizational learning, and the greater the enterprise's competitive advantage. Thus, Hypothesis 3 is supported. Stakeholder pressure was also found to moderate the mediating effect of organizational learning on the relationship between green innovation and enterprises' competitive advantage, thus supporting Hypothesis 5. Similarly, the path coefficients of policy pressure influencing green innovation, organizational learning, and enterprises' competitive advantage were 0.130 (p<0.05), 0.179 (p<0.01), and 0.133 (p<0.05), respectively. This indicates that policy pressure played a positive moderating role in the relationship between green innovation and enterprises' competitive advantage; thus, Hypothesis 4 is supported. Policy pressure also moderated the mediating effect of organizational learning on the main effect, supporting Hypothesis 6.

The path analysis results were consistent with those of the moderated regression analyses. As a supplementary test of robustness (Chang and Chen, 2013), SEM again verified the hypotheses.

Insert Table 7 about here

4.6 Discussion

In the context of China's pursuit of green, low-carbon, circular development, we

propose that implementing a green innovation strategy is an important way for enterprises to meet environmental protection requirements, align with consumer demands, and consolidate competitive advantage. This study selected manufacturing enterprises, which can cause serious environmental pollution, as research objects. The causal steps approach and SEM were used to explore whether, how, and when green innovation affected enterprises' competitive advantage. A functional route from green innovation to organizational learning, and eventually to enterprises' competitive advantage, was revealed, and this process was significantly moderated by stakeholder pressure and policy pressure. These findings have crucial theoretical and managerial implications for green innovation and related research.

4.6.1 Theoretical contributions

First, this study demonstrated a positive correlation between green innovation and enterprises' competitive advantage against the background of sustainable production and consumption. Green innovation requires enterprises to integrate green concepts and innovative thinking into the whole product life cycle. It is a proactive strategy that seeks change and pursues long-term development (Triebswetter and Wackerbauer, 2008). Enterprises should seek to consume as few materials and as little energy as possible in design and production processes and strive to reduce pollutant emissions and promote recycling in daily operations. As a result, production costs can be reduced, and circulating funds are accumulated, which synergistically strengthen the self-capability of enterprises to participate in market competition (Chen et al., 2006). In addition, consumers prefer products and companies that are innovative, socially responsible, and meaningful. Investment in green R&D and innovation can foster such an advanced corporate image. First-mover advantage and innovation compensation will also help compensate for the huge resources consumed by green technology upgrades (Kemp, 2010). Compared to enterprises that passively accept green revolution, those that proactively implement green innovation tend to have comparative

competitive advantages. In summary, the division of self-capability and comparative advantage in enterprises' competitive advantage in this study clarifies the functional pathways of green innovation strategies. Our multiphase, multisource survey also generated relevant empirical evidence, thus adding to the validity, utility, and scope of the Porter hypothesis.

Second, we expanded KBV into the domain of green innovation (March, 1991). Resource-based theory provides useful insights for understanding differentiated competitive advantages among enterprises. However, as nonmaterial elements such as information and knowledge become competitive resources, organizational learning has been increasingly recognized as an important means by which competitiveness is achieved. This study introduced organizational learning as the pivotal mechanism underlying green innovation and enterprises' competitive advantage, uncovering the internal functional route by which macrolevel, abstract business strategies transform into actual competitive advantage (Valentim et al., 2016). At the same time, the division of exploratory and exploitative learning refines the diverse effects of different types of organizational learning. Exploration was found to break through physical boundaries among organizations and departments to establish a rich knowledge base for formulating and implementing green innovation strategies. By contrast, exploitation focuses on using existing knowledge to explain new strategies (Yalcinkaya et al., 2007). This way of learning, characterized by incremental change, helps enhance employees' recognition of new things. A research framework that integrates explicit resources and intrinsic motivation holds much promise for a better understanding of strategic management. Furthermore, partial mediation also indicates that there is no single mediator (e.g., intrinsic motivation) that explains the effect of all antecedents of competitive advantage. Future work should therefore pay more attention to the interconnection mechanism linking business strategies and corporate performance.

Third, this study further advances our understanding of the boundary conditions of the proposed functional route by introducing external pressures (including stakeholder and policy pressures) as moderators. Green innovation was found to better promote enterprises' competitive advantage through organizational learning under high levels of stakeholder pressure and policy pressure. Different from the three conceptual categories of regulation, norms, and cognition (Scott, 1995; Zhu et al., 2013), we identified two specific sources of pressure faced by manufacturers: stakeholders (e.g., consumers and local communities) and policies (e.g., laws and regulations). Our focus on stakeholder and policy pressures in green innovation research is in line with the reality faced by Chinese enterprises (Karassin and Bar-Haim, 2016; Zhang et al., 2017). With its unique institutional and economic conditions, China provides an appropriate research context for investigating how mandatory regulations and guiding consumption trends may affect corporate strategic decision-making. The findings therefore enrich our understanding of the Chinese business environment.

Fourth, we developed theoretical arguments and provided empirical evidence for a unique moderated mediation effect. Here, when stakeholder or policy pressure is high, green innovation has greater indirect effects on enterprises' competitive advantage via organizational learning. Policy, as a fundamental constraint on business operations (Berrone et al., 2013), more strongly promotes the proposed mediating effect. Hence, our findings provide a theoretical reference to help enterprises proactively fulfill environmental responsibilities and generate differentiated competition. The current study also sheds light on how enterprises in emerging economies such as China obtain legitimacy. Furthermore, moderated mediation also offers a convincing method for investigating corporate performance in complex environments.

4.6.2 Managerial implications

First, establishing competitive advantage requires synergetic interplay between green

innovation strategy and organizational learning activity. To comply with environmental regulations and cater to green production, operation, and consumption trends, enterprises need to integrate green ideas into a product's entire life cycle. Accordingly, organizational learning at different levels, from different organizations, and with different characteristics is necessary (Gerschewski et al., 2015). Managers need to regularly organize collective learning for employees at different levels. Formal strategy seminars and informal exchange meetings can be combined to ensure that information and expertise are shared among different employees and departments. Meanwhile, establishing regular information exchange mechanisms with external organizations (including external individuals) can also help break the dependence on existing knowledge bases or learning routines. For example, enterprises can invite customers to visit production facilities and encourage them to propose suggestions for improvement. Seminars for core knowledge employees from different enterprises can be organized to promote diverse knowledge sharing and thereby improve the novelty of green innovation (Yao et al. 2020). In addition, synergy between exploratory and exploitative learning has complementary effects on the implementation of green innovation strategies (Salonen et al., 2018). Enterprises should make full use of existing resources (e.g., information, knowledge, and technologies) through exploitative learning, thereby reducing innovation costs and risks. Correspondingly, exploratory learning can be used to integrate heterogeneous information, thus developing advanced technologies and business models and eventually fostering an image of an innovation leader.

Second, firms should actively respond to stakeholders' calls for green, low-carbon, clean operations while also meeting environmental protection requirements in the era of green consumption (Parmar et al., 2010). With limited available resources, an enterprise first needs to identify the key stakeholders who exert the greatest influence (Rhee et al., 2018). Then, it is necessary to establish contact with them and maintain frequent communication to clearly

understanding their expectations. Light manufacturing enterprises (e.g., textiles, electronics, papermaking) in particular need to keep up with green consumption trends since they sell directly to consumers. They should choose natural, low-emission, low-consumption raw materials; adopt degradable packaging; and recycle used products (Rexhäuser and Rammer, 2014). In addition, the green innovation practices of partners and competitors in the industrial chain can also spur an enterprise to proactively implement green innovation strategies. For example, to cope with the shock brought by electric vehicles, traditional car manufacturers should show foresight and proactively invest in R&D for new-energy vehicles to take the initiative in the next wave of green competition. Therefore, regardless of whether it is from the perspective of "pushing" or "pulling," an enterprise needs to cater to the green expectations of its stakeholders.

Third, compared to stakeholder pressure, policy pressure played a stronger role in stimulating green innovation practices and subsequent competitive advantage. Moderately tight environmental policy will help enterprises to be more active in environmental management. Therefore, in terms of "pushing" and "pulling," governments should impose severe penalties for pollution. High fines, suspensions of business operations, and criminal investigations of executives have all been proven effective (Rubashkina et al., 2015). Meanwhile, supportive policy systems also help enterprises take a positive view of government supervision and strive to proactively carry out green innovation. For example, banks can incorporate green considerations into corporate financing and reduce loans to heavy polluters. Governments can also set aside special funds to subsidize green infrastructure, green technology R&D, and upgrades of outdated equipment (Zhang et al., 2017). Furthermore, firms can make full use of environment-related tax rebates, franchise businesses, and other supporting policies to compensate for additional costs incurred by green innovation. Meeting or exceeding environmental requirements is also conducive to fostering

sustainable competitive advantage.

4.6.3 Limitations and prospects

This study has some limitations, which can highlight meaningful directions for future research. First, the questionnaire items all came from previous studies. However, differences in research background, objects, regions, and other contextual factors require more specific analyses of detailed issues. Hence, future research could reclassify the indicators and develop more careful measures based on the research questions, thereby improving the reliability and validity of the questionnaires. Second, we studied manufacturing enterprises, which are regarded as taking the primary responsibility for pollution. Yet, green innovation is also becoming a crucial transformation direction in other industries, such as agriculture and the service industry. Future studies can include such emerging industries to improve sample diversity and generalizability. Third, we obtained data by means of structured interviews and field questionnaires. In reality, however, organizational learning activities and stakeholder pressures are situational. Thus, researchers are encouraged to use more dynamic methods (e.g., the experience sampling method) to expand our understanding of the relationship between green innovation and competitive advantage.

5 Conclusions

This study empirically showed that green innovation can positively affect enterprises' competitive advantage through the underlying mechanism. Drawing on KBV, our results, based on multiphase, multisource field surveys, indicated that organizational learning is an essential way for enterprises to implement macrolevel strategies. Using a combination of exploitative and exploratory learning, enterprises mitigate conflicts between green innovation strategies and existing business models. Meanwhile, valuable, rare, inimitable, and nonsubstitutable knowledge is created, forming the core capability for participation in fierce market competition. Furthermore, organizational learning at different levels, from different

organizations, and with different characteristics improves employees' recognition of new strategies. Thus, organizational learning not only increases enterprises' self-capability to cope with sustainable production requirements but also enhances their comparative advantage in catering to green consumption trends, ultimately bolstering their competitive advantage.

In addition, under different levels of stakeholder and policy pressure, enterprises have differentiated motives for conducting organizational learning activities. Our moderation model indicated that stakeholder pressure and policy pressure both strengthened the facilitating effects of green innovation on organizational learning. The moderated mediation model further quantified the effect sizes of the two moderators on the main effect, showing that high-level stakeholder and policy pressures exerted more positive promotive effects on the relationship between green innovation strategy and competitive advantage. These findings advance our understanding of the link between green innovation and competitive advantage by uncovering the underlying interconnection mechanism and delineating the boundary conditions. We hope this study can foster further research on the more fine-grained, dynamic mechanisms of the effects of macrolevel innovation strategies on business performance.

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Table 1 Statistics on the key characteristics of valid matched samples

Characteristic	Classification	Sample size	Percentage (%)
Ownership	An SOE and its holding firms	91	38.72
	Private firms	119	50.64
	Wholly foreign-owned firms	8	3.41
	Sino–foreign joint ventures	17	7.23
Firm size	Less than 300 employees	11	4.68
	300–800 employees	127	54.04
	More than 800 employees	97	41.28
Annual turnover	Less than 50 million yuan	7	2.98
	50–80 million yuan	23	9.79
	80–200 million yuan	95	40.42
	More than 200 million yuan	110	46.81
Industry	Steel smelting	42	17.87
	Automobile	26	11.06
	Petroleum	54	22.98
	Papermaking	15	6.38
	Pharmaceutical	37	15.75
	Electrical and electronic	42	17.87
	Textile	11	4.68
	Other	8	3.41
Years of establishment	Less than 3 years	7	2.98
	3–8 years	28	11.91
	9–15 years	132	56.17
	More than 15 years	68	28.94

Table 2 Constructs and items

Construct	Subindex	Item	Reference
Green innovation	Green product innovation	The company chooses green and environmentally friendly materials in the product-design stage.	Chen et al. (2006); Eiadat et al. (2008)
		The company improves production techniques to reduce resource consumption and pollutant emissions.	
		The company possesses a complete and efficient waste recycling system.	
	Green process innovation	The company pursues the coordinated growth of economic and environmental benefits.	
		The company improves production processes in a timely way according to consumers' demand for environmental protection.	
		The company is willing to invest a great deal of resources in environmental technology development.	
Organizational learning	Exploitative learning	The company makes full use of existing technologies and resources.	Atuahene-Gima and Murray (2007); He and Wong (2004)
		Existing products or services reflect the company's advantages and culture.	
	Exploratory learning	The company proactively proposes new product concepts or technical standards.	
		The company actively carries out exchange and cooperation with other organizations.	
		The company thoroughly innovates existing technologies.	
Enterprises' competitive advantage	Self-capability	The company's learning ability is better than that of its competitors.	Chen and Chang (2013)
		The company is able to respond quickly to changes in market demand.	
		The company or department owns abundant circulation capital.	

	Comparative advantage	The company has a good reputation in the market.	
		The company or department has a large number of long-term partners.	
External pressure	Stakeholder pressure	Consumers propose environmental requirements for packaging and production technology.	Zhu et al. (2013)
		Competitors invest a great deal of resources in green innovation.	
		Shareholders demand green operations.	
		Residents monitor the discharge of pollutants by firms at all times.	
	Policy pressure	Production or services face increasingly strict environmental regulations.	
		Violation of relevant environmental regulations will be severely punished.	

Table 3 Confirmatory factor analysis

Model	$\chi 2/df$	RMSEA	SRMR	CFI	TLI	$\Delta\chi 2$	Δdf
Baseline model	2.69	0.08	0.06	0.92	0.91		
Four-factor model	3.83	0.13	0.11	0.84	0.80	190.14**	4
Three-factor model	8.27	0.22	0.18	0.75	0.71	485.97**	7
Two-factor model	13.93	0.28	0.22	0.61	0.58	1081.69**	9
Single-factor model	15.42	0.30	0.25	0.59	0.55	1127.15**	10

Note: **p<0.01; four-factor model: green innovation and organizational learning are combined; three-factor model: green innovation, organizational learning, and enterprises' competitive advantage are combined; two-factor model: green innovation, organizational learning, enterprises' competitive advantage, and stakeholder pressure are combined; single-factor model: all five variables are combined.

Table 4 Descriptive statistics and correlations

Construct	Mean	SD	1	2	3	4	5	6	7
1. Firm size	2.32	0.55							
2. Ownership	1.43	0.50	-0.02						
3. Green innovation	4.52	0.57	0.03	-0.03	(0.82)				
4. Organizational learning	3.55	0.54	0.04	-0.13*	0.19**	(0.76)			
5. Enterprises' competitive advantage	4.51	0.56	-0.03	-0.08	0.28**	0.35***	(0.84)		
6. Stakeholder pressure	4.15	0.67	-0.04	-0.10	0.10	0.19**	0.14*	(0.83)	
7. Policy pressure	4.21	0.75	-0.07	-0.11	0.09	0.19**	0.06	0.39***	(0.77)

Note: *p<0.05, **p<0.01, ***p<0.001 (two-tailed); coefficient alphas are given in parentheses.

Table 5 Moderated regression results

Variable	Organizational learning			Enterprises' competitive advantage			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Firm size	0.030	0.041	0.046	-0.029	-0.035	-0.041	-0.044
Ownership	-0.127*	-0.105	-0.107	-0.082	-0.074	-0.036	-0.035
Green innovation	0.184**	0.160*	0.161*		0.280**		0.223**
Organizational learning						0.350***	0.308**
Stakeholder pressure		0.167**	0.180**				
Policy pressure							
Green innovation × stakeholder pressure		0.138*					
Green innovation × policy pressure			0.144*				
R^2	0.052	0.099	0.100	0.007	0.086	0.128	0.176
F	4.247**	5.024**	5.107**	0.872	7.206**	11.272***	12.254**

Note: *p<0.05, **p<0.01, ***p<0.001.

Table 6 Moderated mediation model results

Moderator	Green innovation (X) → Organizational learning (M) → Enterprises' competitive advantage (Y)				
	Stage		Effect		
	First stage	Second stage	Direct effect	Indirect effect	Total effect
Low stakeholder pressure	0.022	0.350***	0.223**	0.007	0.230**
High stakeholder pressure	0.279**	0.350***	0.223**	0.089*	0.312***
Intergroup difference	0.257**			0.082*	0.082*
Low policy pressure	0.015	0.350***	0.223**	0.004	0.227**
High policy pressure	0.289**	0.350***	0.223**	0.093*	0.316***
Intergroup difference	0.274**			0.089*	0.089*

Note: *p<0.05, **p<0.01, ***p<0.001.

Table 7 Path coefficients and corresponding hypotheses

Function routes	Path coefficient	*p*-value	Hypothesis	Result
Green innovation → enterprises' competitive advantage	0.261	**	Hypothesis 1	Support
Green innovation → organizational learning	0.205	**	Hypothesis 2	Support
Organizational learning → enterprises' competitive advantage	0.293	***	Hypothesis 2	Support
Stakeholder pressure → green innovation	0.127	*	Hypothesis 3	Support
Stakeholder pressure → organizational learning	0.184	**	Hypothesis 3	Support
Stakeholder pressure → enterprises' competitive advantage	0.125	*	Hypothesis 3	Support
Policy pressure → green innovation	0.130	*	Hypothesis 4	Support
Policy pressure → organizational learning	0.179	**	Hypothesis 4	Support
Policy pressure → enterprises' competitive advantage	0.133	*	Hypothesis 4	Support

Note: *p<0.05, **p<0.01, ***p<0.001.

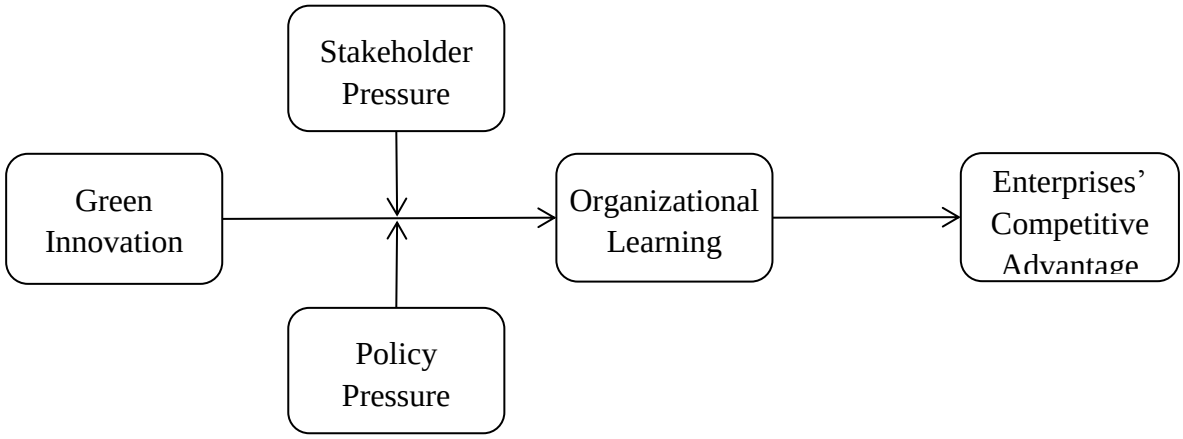

Figure 1 Theoretical framework

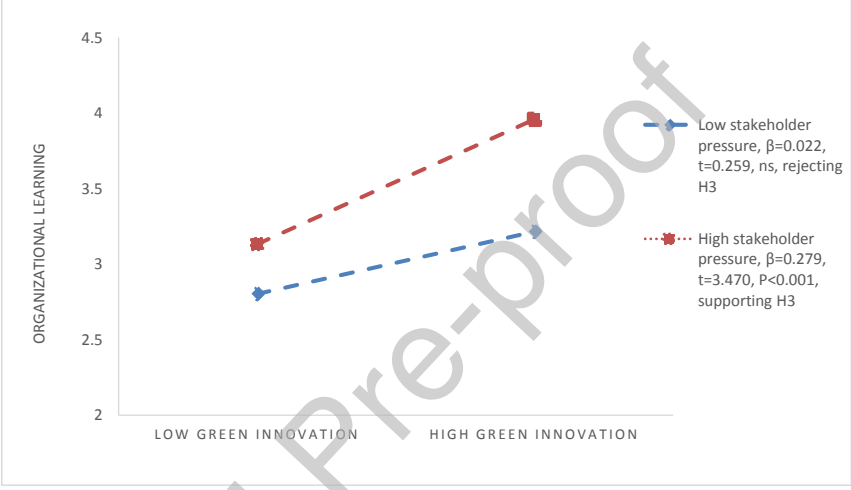

Figure 2 Moderating effect of stakeholder pressure

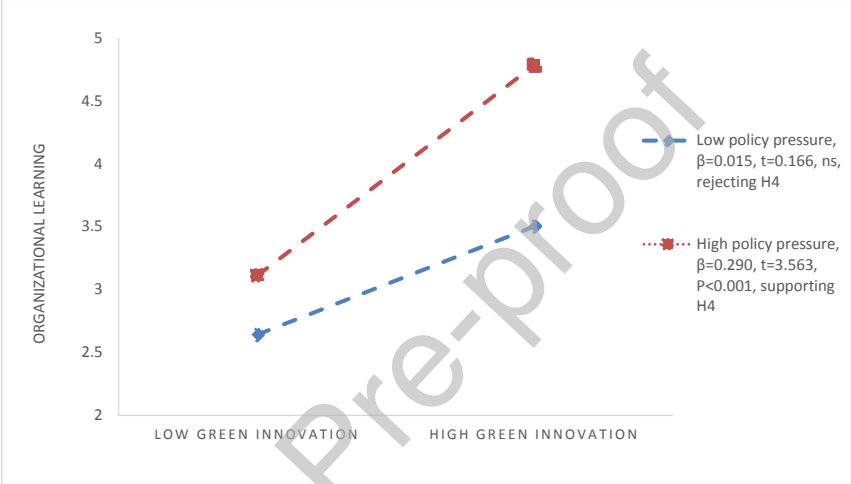

Figure 3 Moderating effect of policy pressure