Environmental Labeling Certification and Corporate Environmental Innovation: The Moderating Role of Corporate Ownership and Local Government Intervention

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ABSTRACT

Although it is well recognized that environmental labeling certification (ELC) is becoming an increasingly important voluntary environmental regulation worldwide, the evidence regarding its role in environmental innovation remains unknown. This study examines the impact of ELC on corporate environmental innovation (CEI) from both external and internal perspectives via the combination of legitimacy theory and the resource management perspective. Based on panel data of listed Chinese manufacturing firms from 2008 to 2014, it is found that ELC improves CEI. However, this relationship is also regulated by two contextual factors: the positive impact of ELC on CEI is found to be stronger for non-state-owned enterprises (non-SOEs) than for state-owned enterprises (SOEs), and it is stronger for firms in regions with a low degree of local government intervention than for firms in regions with a high degree of local government intervention. This study makes important theoretical contributions and has extensive practical value.

Keywords: voluntary environmental regulation, environmental labeling certification, corporate environmental innovation, corporate ownership, local government intervention

1. Introduction

The roots of environmental labeling programs can be found in the growing global concern for environmental protection on the part of governments, businesses, and the public. Following the world's first environmental labeling program, the German Blue Angel ecolabel in 1978, other countries have successively introduced their own environmental labeling programs, such as the Green Seal in the United States, environmental labeling in China, and ABNT Ecolabel-Hummingbird in Brazil. Currently, the Global Ecolabeling Network (GEN)[①] has 27 full members and three associate members representing over 60 countries and four affiliate members that promote and support ecolabeling (GEN, 2019). Via the identification of products that meet the criteria for overall environmental preferability, environmental labeling programs contribute to the reduction in the environmental impacts associated with products (ISO, 2018). Environmental labeling certification (ELC) refers to the issuance of a certificate by an independent external body that has audited a product and verified that it conforms to the requirements specified in the ISO 14024 standard (ISO, 2018). As more countries adopt environmental labeling programs, ELC will continue to play a major role in the environmental governance of firms worldwide.

ELC is a new type of voluntary environmental regulation (VER) that is becoming increasingly common worldwide (Castka & Corbett, 2014). Different from other major VERs (i.e., ISO 14001 certification and environmental information disclosure), ELC is unique in terms of its objects, methods, standards, and goals. Research on ELC remains ongoing; some studies have discussed its antecedents (e.g., Berghoef & Dodds, 2013; Yenipazarli, 2015) and its impacts on consumer purchasing behavior (e.g., Bjørner et al., 2004; Costa et al., 2018), environmental performance (e.g., Wang et al., 2015; Wen & Lee, 2020), and financial performance (e.g., Amacher et al., 2004; Ibanez & Grolleau, 2008). However, little is known about how ELC impacts corporate environmental innovation (CEI), which is the generation of new ideas, goods, services, processes, or management systems in an effort to reduce environmental pollution and achieve sustainability (Rennings, 2000). CEI not only decreases corporate pollution but also improves corporate competitive advantages (Berrone et al., 2013). Moreover, unique environmental initiatives may affect CEI differently. Therefore, due to its uniqueness, the manner in which ELC affects CEI cannot be determined from previous studies that have examined the impacts of other VERs (e.g., ISO 14001 certification and environmental information disclosure) on CEI (e.g., Inoue et al., 2013; Li et al., 2019; Papagiannakis et al., 2019; Yin & Wang, 2018). The research gap in the existing literature limits the understanding of the benefits that ELC can bring to firms in the process of pollution control, which is not conducive to the future promotion of environmental labeling programs and limits the knowledge of the impacts of different VERs on CEI. To fill this important gap, the study focuses on the impact of ELC on CEI. *Therefore, the first research question is posed: How does ELC affect CEI?*

Different from general innovation, environmental innovation has a double externality, i.e., traditional knowledge externalities in the research and development (R&D) phase and environmental externalities in the adoption and diffusion phases (Arfi et al., 2018; Rennings, 2000). Both externalities will reduce a firm's effort and motivation for environmental innovation (Beise & Rennings, 2005; Rennings, 2000). Simultaneously, a firm usually does not have all the resources required to carry out environmental innovation activities (Liao, 2018b). In addition, firms must accumulate, integrate, and develop resources to realize value creation, such as environmental innovation (Sirmon & Hitt, 2003). Therefore, from an external perspective, CEI often requires external pressure to drive and access external resources. From an internal perspective, CEI depends on the internal resource management of firms. Accordingly, CEI is affected by the combined effects of external and internal factors.

Previous research has mainly applied legitimacy theory (Li et al., 2018; Zhou et al., 2021), institutional theory (Berrone et al., 2013; Liao, 2018a), and stakeholder theory (Lin et al., 2014; Zhang & Zhu, 2019) to explore the antecedents of CEI from an external perspective. Legitimacy theory is often used as a theoretical paradigm for explaining firm behavior. According to legitimacy theory, ELC will force a firm to face greater potential legitimacy pressure when it loses its environmental labeling. Furthermore, firms with ELC have a high level of environmental legitimacy, which can help firms obtain external resources (Bansal, 2005; Berrone & Gomez-Mejia, 2009). Therefore, legitimacy theory provides a natural and proper external perspective from which to analyze the impact of ELC on CEI. From an internal perspective, previous research has mainly focused on the resource-based view (RBV). However, the RBV has long been criticized for its inability to explain how resources are managed to create a competitive advantage (Priem & Butler, 2001).

To compensate for this shortcoming, Sirmon et al. (2007) proposed the resource management perspective, which unlocks the connection between resource management and value creation, thereby opening the 'black box' of the process from resources to competitive advantage. Resource management refers to the comprehensive process of structuring a firm's resource portfolio, bundling resources to build capabilities, and leveraging those capabilities with the purpose of creating and maintaining value (Sirmon et al., 2007). The resource management perspective has emerged as a useful paradigm for achieving the competitive advantage of firms. Considering that ELC will force firms to make substantial changes in resource management via environmental product standards and product functional characteristics (Wang et al., 2015; Wen & Lee, 2020), the resource management perspective provides a more appropriate viewpoint for the determination of how ELC affects CEI from an internal perspective. To address the first research question, this study examines the impact of ELC on CEI from both external and internal perspectives via the combination of legitimacy theory and a resource management perspective.

Moreover, the institutional context that will affect the relationships between VERs and CEI is also a topic of great concern. A firm's institutional context includes its internal culture as well as the broader influence of the state, society, and interfirm relations that define socially acceptable economic behavior (Oliver, 1997). Therefore, the institutional context will affect the implementation and effectiveness of VERs (Baek, 2017; Iatridis & Kesidou, 2018; Montiel et al., 2012) and can also shape how firms operate and perform (Peng et al., 2008; Williams & Martinez, 2012). While the relationship between ELC and CEI will be affected by the institutional context, this is not clear in the existing literature, which is not conducive to the understanding of the complex relationship between ELC and CEI in different institutional contexts. This study addresses this gap by discussing the moderating effects of two contextual factors (i.e., corporate ownership and local government intervention) that can affect the motivation, resource acquisition, and internal resource management of certified firms for environmental innovation.

Corporate ownership is an important contextual factor in the innovation literature (e.g., Liao et al., 2019; Liu et al., 2017), and firms with different types of ownership have different advantages in resource acquisition and utilization (Genin et al., 2020; Li & Xia, 2008; Tan & Tan, 2017; Tan & Wang, 2010; Xu et al., 2006). Therefore, the impact of ELC on CEI may vary depending on the type of corporate ownership. To date, local government intervention has been largely ignored in the innovation literature. In regions with different levels of local government intervention, the degree of marketization is different (Wang et al., 2017), as is the manner of resource allocation (Fan et al., 2011; Wang et al., 2017). Therefore, the impact of ELC on CEI may vary with the degree of local government intervention. *Accordingly, a second research question is raised: How do corporate ownership and local government intervention regulate the relationship between ELC and CEI?*

China's environmental labeling program was chosen as the empirical context of the present research for the following reasons. First, China's environmental labeling program occupies a leading international position. To date, the Chinese Environment Certification Center (CEC)[2] has issued a total of 104 effective environmental labeling product standards, and the number of certified products ranks first in the world, having reached 800,000 (GEN, 2019). Second, the results can be extended to other countries, especially developing countries.

The principles and procedures of environmental labeling programs are the same all over the world, and the international mutual recognition of environmental labeling is an inevitable development trend. To date, the CEC has signed cooperation agreements of mutual recognition with environmental labeling agencies in 12 countries, and regions including Thailand, Russia, and Ukraine, to jointly research and implement environmental labeling. As the world's largest developing country, China shares many common features with other developing countries, such as diversified corporate ownership, widespread local government intervention, and prominent environmental problems. In particular, due to weak regulatory pressure and weak nonregulatory pressure from consumers, capital markets, and nongovernmental organizations (NGOs), the debate on the effectiveness of VERs in developing countries remains ongoing (Blackman, 2008; Blackman et al., 2010). However, there is no accurate measurement of environmental performance (Chang et al., 2015). From the perspective of its influence, environmental innovation can be considered innovation aimed at reducing negative environmental impacts (Yin & Wang, 2018). Therefore, the impact of ELC on CEI can be used to reflect the effectiveness of environmental labeling programs. Accordingly, the results also reflect the effectiveness of China's environmental labeling program and have great significance for similar programs in developing countries.

Based on samples from 1,227 manufacturing firms listed in the Chinese A-share market from 2008-2014, the findings suggest that ELC is positively associated with CEI, and this positive effect is stronger for non-SOEs and for firms based in regions with a low degree of government intervention. Moreover, multiple robustness tests and the endogeneity analysis of conventional and heteroscedasticity-based instruments demonstrate that these results are robust.

Compared with the existing literature, this study makes the following main contributions. First, via the combination of legitimacy theory and the resource management perspective, this study explores the link between ELC and CEI from both external and internal perspectives for the first time. Previous studies have focused on the effects of other types of VERs (e.g., voluntary environmental disclosure, ISO 14001 certification) on CEI (e.g., Demirel & Kesidou, 2011; Li et al., 2019; Yin & Wang, 2018). Given the distinct features of different types of VERs, the study extends the investigation of VERs by providing a theoretical explanation for the mechanisms of the relationship between ELC and CEI from external and internal perspectives.

Second, this study reveals the boundary conditions under which ELC promotes CEI by theoretically and empirically examining the moderating effects of corporate ownership and local government intervention.

Third, this study empirically examines the effectiveness of environmental labeling programs in China from the perspective of environmental innovation; thus, contributing to the literature on the ongoing debate on the effectiveness of VERs in developing countries (Blackman, 2008; Blackman et al., 2010).

Finally, this research contributes to the broader literature investigating the antecedents of CEI (e.g., Arena et al., 2018; Galbreath, 2019; Horbach, 2008). While the determinants of environmental innovation are divided into supply-side factors, demand-side factors, and environmental policy factors (Doran & Ryan, 2016; Horbach, 2008; Triguero et al., 2013), previous studies have not theoretically and empirically discussed the impact of ELC as a special environmental initiative on CEI. Moreover, the results of this study are not only important for the future application of environmental labeling programs but also provide crucial implications for policy-makers and firm managers.

2. Literature Review

As an increasingly popular VER globally, the antecedents of ELC have attracted the attention of scholars. Berghoef and Dodds (2013) found that firms are motivated to participate in ELC for continued environmental improvement, increased visibility and an improved public image. The time and money required to obtain certification (Berghoef & Dodds, 2013) and the auditing fees paid per product unit (Yenipazarli, 2015) have been identified as barriers to a firm's participation in ELC. Leroux and Pupion (2018) proposed that for hotels that have not yet adopted such certification, the intention to change its choice depends on normative and mimetic pressures and entrepreneurial characteristics; for certified hotels, the complexities of the certification system are critical in the decision regarding whether to abandon certification.

Previous studies have not only analyzed the antecedents of participating in ELC programs but also explored the consequences of ELC for buying behavior and corporate performance. Many studies show that certified products are favored by consumers in the market and especially by consumers with environmental awareness, as they are more willing to pay a premium for certified products (e.g., Bjørner et al., 2004; Thompson et al., 2010). In the literature on the impacts of ELC on firms, extant studies have explored the impacts of ELC on corporate environmental and financial performance (Amacher et al., 2004; Ibanez & Grolleau, 2008; Wang et al., 2015; Wen & Lee, 2020), but no literature has examined the impacts of ELC on CEI. In terms of the impacts of ELC on corporate environmental performance, the related literature mainly uses mathematical models that present positive results but have not explored the relationship in empirical settings. Ibanez and Grolleau (2008) found that environmental labeling can reduce pollution levels and that under restrictive conditions on labeling costs, environmental labeling can, to some extent, serve as an environmentally effective and economically efficient policy. Moreover, Amacher et al. (2004) concluded that environmental labeling could be used to reduce excessive investment and improve poor environmental quality. However, studies on the impacts of ELC on corporate financial performance mainly develop econometric models and provide mixed results. For example, Wang et al. (2015) found that the impact of environmental labeling on the net profits and returns on the sales of firms are insignificant. Subsequently, Wen and Lee (2020) found that manufacturing firms experience increases in ROA, Tobin's Q, and productivity after obtaining ELC. However, it is not clear how ELC affects CEI and its contextual factors. This limits the understanding of the benefits that ELC can bring to firms in the process of pollution control, which is not conducive to the future promotion of environmental labeling programs.

VERs refer to firms' voluntary commitments to control pollution or carry out environmental protection activities (Bu et al., 2020). Unlike traditional command-and-control environment regulations, VERs are not governed by traditional rules and are characterized by flexibility and autonomy (Jiang et al., 2020). VERs require only the setting of environmental goals but do not regulate the specific approaches used to achieve such goals. Furthermore, the flexibility of VERs provides firms ample room for innovation (Bu et al., 2020). VERs can spur innovation when designed to improve participants' internal management systems, allowing boundedly rational managers to systemically identify points of resource waste (Lim & Prakash, 2014).

VERs include requiring external agencies to assist during execution, including ELC, ISO 14001 certification, the Eco-Management and Audit Scheme (EMAS), and environmental agreements, as well as independent methods such as voluntary environmental disclosure. Of these, ELC, ISO 14001 certification and voluntary environmental disclosure are more commonly developed and adopted worldwide. Despite their common voluntary nature, these three types of VERs differ in certain ways (see Table 1).

<Insert Table 1 about here>

As shown in Table 1, while both ELC and ISO 14001 certification require third-party certification, ELC is a product-based initiative, whereas ISO 14001 certification is a process-based initiative (Wang et al., 2015). Unlike ELC and ISO 14001, voluntary environmental disclosure is an environmental information-based initiative that does not necessarily require third-party certification. Furthermore, the implementation standards and goals of the three VERs are different. ELC implements the ISO 14024 standard and aims to reduce environmental impacts associated with products through the identification of products that meet the criteria of a specific environmental labeling program for overall environmental preferability (ISO, 2018). However, ISO 14001 certification implements the ISO 14001 standard and aims to enable a firm to achieve the intended outcomes it sets for its environmental management system, including enhancement of environmental performance, fulfillment of compliance obligations and achievement of environmental objectives (ISO, 2015). For voluntary environmental disclosure, firms may choose to disclose content and methods in ways that are beneficial to them (Villiers & van Staden, 2011). This may be related to its purpose, which addresses environmental concerns from stakeholders (Sun et al., 2019). Therefore, the significant differences between ELC and the two other types of VERs lie in their objects, methods, standards, and objectives.

Although the extant literature provides extensive and in-depth discussions on the relationship between VERs and CEI, such studies only focus on the impacts of ISO 14001 certification and voluntary environmental disclosure on CEI. For example, a study of 289 UK firms shows that ISO 14001 certification is significantly positively correlated with both end-of-pipeline technologies and environmental R&D but finds no effect on Integrated Cleaner Production Technologies (Demirel & Kesidou, 2011). A positive link was also found between ISO 14001 certification and CEI for the top 100 listed firms in China (Li et al., 2019). We found only one study on heavily polluting listed firms in China investigating the impact of voluntary environmental disclosure on CEI, which shows that voluntary environmental disclosure promotes CEI (Yin & Wang, 2018). However, the impact of ELC on CEI has not been examined. Given that the three VERs listed above have different characteristics in some respects, their effects on CEI are distinct. Therefore, the results of these studies cannot be simply extended to the impact of ELC on CEI, which limits knowledge on the impacts of different VERs on CEI.

To fill this research gap, this study considers both the external and internal perspectives via the combination of legitimacy theory and the resource management perspective and takes

China's environmental labeling program as the empirical context to examine how ELC affects CEI. In addition, the moderating effects of two contextual factors (i.e., corporate ownership and local government intervention) are further analyzed.

3. Theory and Hypotheses

This study examines how ELC affects CEI from both external and internal perspectives via the combination of legitimacy theory and the resource management perspective, which have not previously been extensively used together. Legitimacy is a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions (Suchman, 1995). In terms of legitimacy theory, organizations are considered a part of the broader social system without any inherent rights to resources (Deegan, 2002). Legitimate organizations can maintain access (or 'rights') to required resources (Deegan, 2019). Accordingly, firms require legitimacy to continue their operations (Gray et al., 1996). However, gaining legitimacy is very difficult for firms (Suchman, 1995). Certain actions and events of firms increase their legitimacy, and others decrease it (Tilling & Tilt, 2010).

Environmental labeling is associated with legitimacy. Firms' participation in environmental labeling programs is a generally accepted social norm and even a moral obligation (Donaldson & Dunfee, 1994). From the perspective of legitimacy theory, the action of a firm can be desirable, proper, or appropriate (Wang et al., 2015), and ELC, therefore, increases firms' environmental legitimacy (Berrone et al., 2009; Li et al., 2017). However, if certified firms do not maintain their ELC, they risk losing their environmental legitimacy, which will reduce their overall legitimacy, i.e., it will force firms to face greater legitimacy pressure. Furthermore, firms with ELC have a high level of environmental legitimacy; such firms can improve their relationships with and win the support of their stakeholders, thereby obtaining better trading conditions and more relevant resources (Bansal, 2005; Berrone & Gomez-Mejia, 2009).

In addition, ELC also influences CEI through internal resource management. However, in its present articulation, legitimacy theory is unable to address wider systemic issues (Archel et al., 2009), e.g., how firms manage resources. The perspective of resource management unlocks the connection between resource management and value creation, thereby opening the 'black box' of the process from resources to competitive advantage (Sirmon et al., 2007). It argues that merely possessing valuable, rare, nonimitable, and nonsubstitutable resources cannot guarantee the development of a competitive advantage and create value, such as environmental innovation (Priem & Butler, 2001). Firms must accumulate, integrate, and develop resources to realize value creation, such as environmental innovation (Sirmon & Hitt, 2003). Therefore, the resource management perspective can be used to examine the internal resource management of certified firms. According to the environmental criteria and functional characteristics of products, firms are forced to make substantial changes in resource management to reduce the negative impact on the environment at all stages of the product life cycle (Wang et al., 2015; Wen & Lee, 2020). Therefore, ELC can lead to the environmentally friendly utilization of a firm's resources and reduce the firm's pollution emissions (Ibanez & Grolleau, 2008). From the resource management perspective, because pollution reflects the unnecessary, inefficient, or incomplete usage of firm resources (Porter & Van der Linde, 1995), ELC can also improve a firm's resource utilization efficiency.

3.1. *ELC and CEI*

According to legitimacy theory, ELC improves CEI by enhancing firms' motivation for environmental innovation and promoting firms' access to resources. Due to the double externality (Beise & Rennings, 2005; Rennings, 2000) and limited resources for CEI (Liao, 2018b), CEI often requires external pressure to drive and access external resources. From the perspective of legitimacy theory, ELC can be used by firms as a tool to improve environmental legitimacy (Li et al., 2017). However, if a firm loses its environmental labeling, its legitimacy will be lessened, and the firm will face greater legitimacy pressures. Low legitimacy will have particularly negative consequences for an organization, which may eventually lead to the loss of its right to operate (Tilling, 2004; Tilling & Tilt, 2010), and to the imposition of sanctions by its stakeholders (Luft Mobus, 2005). Given that maintaining legitimacy is easier than gaining or regaining (repairing) it (de Villiers & van Staden, 2006), the best strategy for certified firms is to protect past accomplishments and, thereby, maintain their level of legitimacy (Suchman, 1995). Consequently, the motivation for CEI is strengthened to avoid potentially greater legitimacy pressures. Certified firms are forced to increase investments in environmental innovation and to constantly update production technologies and processes to maintain ELC. Moreover, certified firms have a high level of environmental legitimacy, which helps them improve their relationships with stakeholders and win their support, thereby facilitating the acquisition and use of external financial resources, knowledge, and information

(Bansal, 2005; Berrone & Gomez-Mejia, 2009), which will alleviate the problem of insufficient resources, knowledge, and capabilities in the process of CEI (Liao, 2018a). Moreover, it will enrich the knowledge base (De Marchi, 2012) and help firms generate new ideas, form new perspectives, and reduce innovation uncertainty (Cui et al., 2020), thereby promoting CEI (Cainelli et al., 2015).

According to the resource management perspective, ELC improves CEI by comprehensively improving resource utilization efficiency. In environmental labeling programs, a product is forced to comply with product environmental standards and product functional characteristics that set out the technical requirements (ISO, 1999, 2018). Therefore, firms are forced to make substantial changes to the process of resource management to contribute to a reduction in the environmental impacts associated with products (Wang et al., 2015; Wen & Lee, 2020). This will cause firms to reduce waste and pollution in the product life cycle stages, including resource acquisition, production, sale, use, and disposal (ISO, 2018). Because pollution reflects the unnecessary, inefficient, or incomplete utilization of resources (Porter & Van der Linde, 1995), from the perspective of resource management, ELC can also comprehensively improve resource utilization efficiency, such as via the recovery and recycling of waste materials, lower energy consumption, and the reduction of unnecessary packaging (Wang et al., 2015; Wen & Lee, 2020). For example, to comply with the environmental protection requirements of the ‘China Environmental Labeling Product Certification Implementation Rules for Light Vehicles (ECC-1020EL-A/0)’, China FAW Group Co., Ltd. promotes clean production; they closely focus on maximizing resource utilization efficiency and minimizing pollution during the production process of the Hongqi H5 sedan. In terms of material recycling, more than 95% of the vehicle materials of the Hongqi H5 sedan can be recycled. Furthermore, the 4GC18TD engine in the sedan adopts in-cylinder direct injection, supercharged intercooling, and dual VCT variable valve timing technology, and its fuel consumption is reduced by more than 15% compared with the same engine with power port injection.[3] The process of improving resource utilization efficiency can enable firms to continuously learn and develop new knowledge and technologies, thereby upgrading production processes and adopting cleaner production technologies, ultimately leading to environmental innovation (Park, 2014).

More importantly, the positive effect of ELC on CEI is an ongoing process. In environmental labeling programs, particular product environmental criteria and product function characteristics are reviewed within a predefined period and revised from time to time, taking into account factors such as new technologies, new products, new environmental information and market changes (ISO, 2018). The revised environmental standards and functional characteristics of products have higher technical requirements. To avoid the potentially greater pressure of legitimacy, firms are more motivated to carry out environmental innovation so that their products meet the technical requirements for maintaining ELC. In the process of maintaining ELC, the environmental legitimacy of certified firms is maintained. Therefore, firms still have access to external resources for CEI. According to the revised product environmental standards and product functional characteristics, ELC can further improve the resource utilization efficiency of certified firms.

Based on the preceding discussion, Hypothesis 1 was proposed as follows:

Hypothesis 1 (H1): ELC promotes CEI.

3.2. ***The Moderating Effects of Corporate Ownership***

Corporate ownership has various forms that can be further divided into state ownership and non-state ownership (Delios et al., 2006). In SOEs, production assets belong to the state, which is the de facto representative of official owners (Park et al., 2006). Non-SOEs mainly include privately owned enterprises, collectively owned enterprises and foreign-owned enterprises (Li & Xia, 2008).

SOEs have a natural tie with the government that commands significant influence and resources not available to the general public and is the most important stakeholder for firms. Therefore, compared with non-SOEs, SOEs enjoy advantages in legitimacy and resource acquisition (Li & Xia, 2008; Tan & Tan, 2017; Xu et al., 2006). For example, governments give priority to providing SOEs with various forms of support, such as land supplies, public subsidies and industry permits (Tan et al., 2007). State-owned financial institutions tend to issue loans to SOEs based on political rather than economic considerations (Feng & Wang, 2010). Conversely, non-SOEs are subject to greater pressure for legitimacy and greater constraints on resources (Xu et al., 2006), and it is difficult for them to obtain government support (Li & Xia, 2008) and bank loans (Lu et al., 2005). Non-SOEs need to rely on improving and strengthening relationships with stakeholders from the improvement of environmental legitimacy through ELC to acquire more external resources. Therefore, compared with SOEs, non-SOEs are more motivated to use external resources in the environmental innovation process to maintain their ELC and legitimacy.

However, SOEs also have disadvantages in resource utilization compared with non-SOEs (Genin et al., 2020; Tan & Wang, 2010; Xu et al., 2006). Due to their disadvantages in terms of resource acquisition and governmental support, non-SOEs are more likely to adopt an organic organizational structure and rely on market-supporting systems to increase operational efficiency (Li & Xia, 2008). Such an organic organizational structure is flexible, flat and less hierarchical, which permits and encourages communication and coordination among employees, rewards teamwork, and increases information exchange, knowledge sharing and cross-departmental collaboration (Wei et al., 2011). It thus benefits the process of knowledge management (Claver-Cortes et al., 2007) and increases organizational intellectual capital (Ramezan, 2011). Therefore, non-SOEs outperform SOEs in terms of resource utilization efficiency (Li & Xia, 2008; Zhang et al., 2001, 2003). Compared with SOEs, ELC has a stronger role in promoting the environmental innovation of non-SOEs due to their advantages in resource utilization.

Based on the preceding discussion, Hypothesis 2 was proposed as follows:

Hypothesis 2 (H2): Compared with SOEs, ELC for non-SOEs has a greater effect on promoting CEI.

3.3. *The Moderating Effects of Local Government Intervention*

Local government intervention refers to the intervention of local government in the market (Fan et al., 2011; Wang & Xu, 2011; Wang et al., 2017). The higher the government-market relationship index is, the lower the degree of local government intervention (Fan et al., 2011;

Wang et al., 2017). Market mechanisms function fully in regions with a low degree of local government intervention.

Regions with a low degree of local government intervention have high levels of marketization (Wang et al., 2017) and more symmetrical information among economic entities (Cordeiro et al., 2013). Environmental labeling programs demonstrate transparency and comprehensiveness through all stages of development and operation (ISO, 1999, 2018). ELC indicates that certified products have overall environmental preferability in their product category based on life cycle considerations (ISO, 2018). For stakeholders in the market, environmental labeling programs are credible (De Chiara, 2016). Therefore, firms can gain environmental legitimacy among stakeholders through ELC (Hunter & Bansal, 2007). However, due to well-developed market mechanisms and high transparency of information, if a firm loses its environmental labeling, it will face greater legitimacy pressure. In these areas, the firms' motivation for environmental innovation is stronger. These stakeholders trust such certified firms (Gosselt et al., 2017) and are willing to provide increasingly higher quality resources for CEI (Kafouros & Forsans, 2012). Furthermore, certified firms use more acquired resources in the process of environmental innovation to maintain their ELC. In these regions, the role of ELC in facilitating firms' access to resources is also strengthened. However, information asymmetry is a serious issue in regions with a high degree of local government intervention. Because of information asymmetry, stakeholders are not sufficiently informed about environmental labeling programs or do not trust them (Taufique et al., 2017). Therefore, it is difficult for firms to gain environmental legitimacy among stakeholders through ELC. In these regions, firms' motivation for environmental innovation is weak, and the role of ELC in promoting firms' access to resources is weakened.

In addition, the market plays a dominant role in resource allocation in regions with a low level of local government intervention (Fan et al., 2011; Wang et al., 2017). In the low intervention context, resources flow from low-productivity firms to high-productivity firms (Pan et al., 2013). ELC can improve firms' resource utilization efficiency. Therefore, firms in regions with a low degree of local government intervention are more willing to maximize resource utilization efficiency through ELC. Moreover, firms are likely to extend the knowledge and skills learned from the production of certified products to the production of uncertified products to improve resource utilization. Therefore, in these regions, the role of ELC in resource utilization is strengthened. However, the pattern of resource allocation changes from market-led to government-led in regions with high degree of local government intervention. The allocation of resources in such regions is mostly conducted or channeled by local governments, which can distort the function of the market and cause the allocation of resources to be inefficient (Wang, 2018). Firms in such regions mainly rely on relationships with local governments to acquire resources (Yi et al., 2013). In this high intervention context, more resources flow to firms that have good relations with the government than to firms with high production efficiency. Therefore, firms are likely to lack the motivation to improve resource utilization efficiency through ELC. However, they may be more willing to establish relationships with the government. Thus, in these regions, the impact of ELC on resource utilization is weakened. Compared with regions with high levels of local government intervention, ELC in regions with low degree of local government intervention plays a greater role in the improvement of firms' resource utilization efficiency.

Based on the preceding discussion, Hypothesis 3 was proposed as follows:

Hypothesis 3 (H3): ELC in regions with a low degree of local government intervention has a greater effect in promoting CEI than in regions with a high degree of local government intervention.

Figure 1 presents the conceptual model of this study.

<Insert Figure 1 about here>

4. Research Design

4.1. *Sample and Data Collection*

Manufacturing firms are the most important participants in environmental labeling programs and the main source of environmental problems in China. Therefore, this study selects A-share listed firms from the manufacturing sector during the 2008-2014 period as a research sample. To ensure the reliability and validity of the sample, this study excluded firms with more serious missing observations. After excluding missing observations and observations of firms listed after 2013, since the independent variable lags by one period, the sample includes 1,227 firms with 7,099 firm-year observations. Table 2 reports the sample distribution of listed firms with ELC by industry for 2014. The proportion of certified firms in 2014 was 5.8%.

<Insert Table 2 about here>

In this study, the data sources for all variables are as follows: (1) Information on listed firms' ELC was manually collected from the "*Environmental Label Certification Corporate List*" issued by the CEC; (2) Environmental patent data for the studied firms were collected from the *Baiteng Patent Network* (https://www.baiten.cn/), which is an authoritative patent database widely used by researchers in China (e.g., Li et al., 2018); (3) Data on corporate ownership were collected from the CCER database (http://www.ccerdata.cn/); and (4) Data on levels of local government intervention were derived from the "Marketization Index of China's Provinces: NERI Report 2016" compiled by Wang et al. (2017). This report quantifies changes in the levels of local government intervention in 31 Chinese provinces from 2008 to 2014. Moreover, data for the control variables were drawn from the CSMAR database (http://cndata1.csmar.com/). Since there are multiple sources of variable data, we accurately match the data by the name of the listed firm, stock code, year and the name of the province where the address is registered.

4.2. ***Variables and Measures***

4.2.1. Dependent Variable

Corporate environmental innovation (CEI). Drawing on the research of Lim and Prakash (2014), this study uses the number of environmental patent applications of listed firms to measure CEI. There are several advantages to using patent data to measure CEI. *First*, patents can be quantified (Guan & Yam, 2015) and allow researchers to compare firms' innovative performance in new technologies, processes and products (Hagedoorn & Cloodt, 2003). *Second*, the patent specification provides a detailed introduction to patents, allowing researchers to classify patents based on keywords such as patent types and technical characteristics (Guan & Yam, 2015). In this study, we identified patents involving hazardous or toxic waste destruction or containment, waste recycling or reuse, acid rain prevention, solid waste disposal, alternative energy sources, air pollution prevention and water pollution prevention as environmental patents (Brunnermeier & Cohen, 2003). As observations of environmental patent applications with a value of 0 accounted for 65.69%, to minimize the effects of heteroscedasticity on the regression results and avoid losing the sample after taking the natural logarithm of the number of environmental patent applications, we converted the number of environmental patent applications using the natural logarithm of one plus the number of applications to measure CEI (Fang et al., 2014).

4.2.2. Independent Variable

Environmental labeling certification (ELC). This study constructs a dummy variable as a measurement of ELC. Certified firms in a given year are coded as 1; other firms are coded as 0 (Wang et al., 2015).

4.2.3. Moderating Variables

Corporate ownership (OWN). According to the final controller classification, Chinese listed firms can be divided into state and non-state owned firms (Delios et al., 2006). The ultimate controllers of SOEs are the local and central governments. The ultimate controllers of non-SOEs are collective enterprises, foreign-invested enterprises and individuals (Meng et al., 2013). We construct a dummy variable that measures OWN. For non-SOEs, a value of 1 is assigned; otherwise, a value of 0 is assigned (Lu et al., 2012).

Local government intervention (LGI). We use an index of the relationship between the government and market taken from the "*Marketization Index of China's Provinces: NERI*

Report 2016" published by (Wang et al., 2017) to measure the degree of local government intervention in the province where a firm's address is registered (Wang & Xu, 2011). The index reflects the degree of local government intervention in the market based on three measures: the proportion of economic resources allocated by the market, the reduction of government intervention in firms, and the reduction of government size (Wang et al., 2017). The relationship between the index and local government intervention is inverse, so the larger the index, the lower the degree of local government intervention.

4.2.4. Control Variables

Drivers for CEI are divided into internal and external factors. To avoid interference from other possible influencing factors in the results of the regression analysis, according to the existing literature, we control two sets of control variables in the regression model. Internal factors include corporate characteristic variables, R&D activities, etc. External factors include environmental management system certification (EMSC), quality management system certification (QMSC), and emission trading systems (ETS).

Corporate age (AGE). Corporate age controls for differences in listed firm age. Older firms may exhibit more organizational inertia and be less likely to innovate (Zona et al., 2013). Corporate age is measured as the number of years passed since a listed firm was founded (Yi et al., 2013).

Corporate size (SIZE). Corporate size controls for differences in the sizes of listed firms. A firm's size will affect its tendencies to implement environmental innovation, where small and medium-sized firms may face more difficulties with the complexities of environmental innovation (De Marchi, 2012). Corporate size is measured by the natural logarithm of total assets (Heyman et al., 2008).

Return on assets (ROA). Return on assets controls for differences in the profitability of listed firms. More profitable firms can take on expensive projects such as those involving research in environmental innovation (Arena et al., 2018). Return on assets is measured by net profits divided by average total assets (Firth et al., 2013).

Financial leverage (LEV). Financial leverage controls for differences in the financing capacities of listed firms. Bank loans can be a viable means of financing for innovative firms (Chava et al., 2017). Financial leverage is measured as total debt divided by total assets (Lu et al., 2012).

R&D intensity (R&D). R&D intensity controls for differences in the R&D activities of listed firms. The existing literature shows that R&D activities contribute to CEI (De Marchi, 2012; Horbach, 2008). *R&D* intensity is measured by R&D expenditures divided by total assets (Lanis & Richardson, 2015).

Environment management system certification (EMSC). The EMSC controls for differences in the environmental management activities of listed firms. The comprehensiveness of an environmental management system is an environmental management practice (Delmas & Toffel, 2004). There are many forms of environmental management system certification, with ISO 14001 certification being the most widely used. Therefore, we construct a dummy variable to measure EMSC. ISO 14001 certified listed firms are coded as 1; other firms are coded as 0.

Quality management system certification (QMSC). QMSC controls for differences in the product quality management of listed firms. QMSC promotes the diversification of corporate activities and affects the innovation capacities of firms (Terziovski & Guerrero, 2014). Mangiarotti and AF Riillo (2014) found that ISO 9000 certification will increase the innovation tendencies of manufacturing firms. We use a dummy variable to measure QMSC. ISO 9000 certified listed firms are coded as 1; other firms are coded as 0.

Emissions trading system (ETS). ETS controls for differences in the implementation of emissions trading systems in the province where a firm's registered address is located. To meet regulatory requirements, Zhang et al. (2019) showed that ETSs pressure firms to implement environmental innovation. We construct a dummy variable as a measurement of ETS. Provinces implementing emission trading systems are coded as 1; other provinces are coded as 0 (Huang & Chen, 2015).

4.3. *Model Specification*

To test the relationship between ELC and CEI and the moderating effects of corporate ownership and local government intervention while considering the lag effect of ELC on CEI, we construct the following regression model (*see* Model (1)) to test the main effect.

$$CEI_{i,t} = \alpha_0 + \alpha_1 ELC_{i,t-1} + \alpha_2 OWN_{i,t-1} + \alpha_3 LGI_{i,t-1} + \varphi Controls_{i,t-1} + Year_t + Industry_j + Province_k + \varepsilon_{i,t} \quad (1)$$

We use OLS estimation for this model. In the model, dependent variable $CEI_{i,t}$ refers to the environmental innovation performance of listed firm *i* in year *t*. $ELC_{i,t-1}$ represents the ELC of listed firms. $OWN_{i,t-1}$ denotes the ownership of listed firms. $LGI_{i,t-1}$ refers to the degree of local government intervention in the province where a listed firm is registered. $Controls_{i,t-1}$ represents the sets of control variables used in this study. In the model, we also control year fixed effects $Year_t$, industry fixed effects $Industry_j$, and province fixed effects $Province_k$, and $\varepsilon_{i,t}$ is a random error term.

To test the moderating effects of corporate ownership and local government intervention, we use two interaction terms: $ELC_{i,t-1} * OWN_{i,t-1}$ and $ELC_{i,t-1} * LGI_{i,t-1}$. To avoid multiple collinearity in our regression analysis, we multiply the variables generated after standardizing $ELC_{i,t-1}$, $OWN_{i,t-1}$, and $LGI_{i,t-1}$ to obtain two interactive terms.

Model (2) examines the moderating effect of corporate ownership. If the estimated coefficient β_3 is positively significant, H2 holds.

$$CEI_{i,t} = \beta_0 + \beta_1 ELC_{i,t-1} + \beta_2 FO_{i,t-1} + \beta_3 ELC_{i,t-1} * OWN_{i,t-1} + \beta_4 LGI_{i,t-1} + \sigma Controls_{i,t-1} + Year_t + Industry_j + Province_k + \varepsilon_{i,t} \tag{2}$$

Model (3) examines the moderating effect of local government intervention. If the estimated coefficient γ_3 is positively significant, H3 holds.

$$CEI_{i,t} = \gamma_0 + \gamma_1 ELC_{i,t-1} + \gamma_2 LGI_{i,t-1} + \gamma_3 ELC_{i,t-1} * LGI_{i,t-1} + \gamma_4 OWN_{i,t-1} + \vartheta Controls_{i,t-1} + Year_t + Industry_j + Province_k + \varepsilon_{i,t} \tag{3}$$

5. Data Analyses and Results

5.1. *Descriptive Statistics and Correlation Analysis*

Table 3 reports descriptive statistics and Pearson correlation of variables. The mean, standard deviation and maximum value of *CEI* are 0.47, 0.76 and 5.77, respectively, revealing considerable differences in environmental innovation performance among listed firms. The mean value and standard deviation of *ELC* are 0.03 and 0.17, respectively. The mean value and standard deviation of *OWN* are 0.57 and 0.50, respectively. The standard deviation and minimum and maximum values of the *LGI* are 7.12, -6.75 and 9.65, respectively. This indicates that the degrees of local government intervention imposed on listed firms in different provinces differ considerably. Table 3 shows that the absolute value of the Pearson correlation coefficient between variables is less than 0.41, indicating that potential multicollinearity problems between variables are not serious.

<Insert Table 3 about here>

5.2. *Hypothesis Tests*

Table 4 reports our regression analysis results. Model 1 includes the main effects of ELC, corporate ownership, and local government intervention on CEI and tests the effect of ELC on CEI. Model 2 adds an interaction term between ELC and corporate ownership to test the moderating effect of corporate ownership. Model 3 adds an interaction term between *ELC* and *LGI* to test the moderating effect of local government intervention. Model 4 is the full model, including all variables examined in this study.

<Insert Table 4 about here>

H1 predicts that ELC will promote CEI. In Model 1, the estimated coefficient of *ELC* is significantly positive, indicating that ELC will significantly promote CEI. Therefore, H1 is supported.

H2 predicts that corporate ownership will regulate the impact of ELC on CEI. In Model 2, the estimated coefficient of the interaction term ($ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$) is significantly positive, indicating that compared to SOEs, the ELC of non-SOEs plays a stronger role in promoting CEI. H2 is, thus, supported. To better explain this finding, we provide a moderating effect map of corporate ownership. As shown in Figure 2, the slope of the dotted line (non-SOEs) is steeper, indicating that compared to that of state-owned listed firms, the positive relationship between ELC and CEI is stronger for non-state-owned listed firms.

<Insert Figure 2 about here>

H3 predicts that local government intervention will regulate the effect of ELC on CEI. In Model 3, the estimated coefficient of the interaction term ($ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$) is significantly positive, indicating that compared to regions with high degrees of government intervention, ELC in regions with low degrees of government intervention is more effective in promoting CEI. H3 is, thus, supported. To better explain this finding, we also plot a moderating effect map of local government intervention. As shown in Figure 3, the slope of the dotted line is slightly steeper, indicating that compared to regions with a high degree of government intervention, the positive relationship between ELC and CEI is stronger in regions with a low degree of government intervention.

<Insert Figure 3 about here>

Model 4 is the full model with two interaction terms ($ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$ and $ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$). Compared to the previous regression results, the estimated coefficients of the *ELC* and the two interaction terms are basically the same, indicating that the results of the hypothesis test are robust. In addition, we find that *SIZE*, *ROA*, *LEV*, *R&D*, *EMSC* and *QMSC* in the control variables have a significantly positive effect on CEI.

6. Robustness Checks

To ensure the validity and universality of our research results, we conduct a series of robustness tests. First, we use alternative indicators to measure ELC and CEI and test the sensitivity of the results to different measures of variables. Second, we use Tobit regression and multilevel regression to estimate the models and test the sensitivity of the results to different regression methods. In addition, we further examine the long-term effect of ELC on CEI.

6.1. *Alternative Measure of ELC*

In business practice, according to different product environmental standards implemented by third-party certification bodies, it is possible for firms to apply for ELC for many different products that they produce. Therefore, a listed firm may apply for environmental labeling multiple times to a third-party certification body within one year. As a result, some listed firms may obtain more ELC certificates than others. Compared to the constructed dummy variables, the number of ELC certificates (*ELC_N*) that a listed firm receives each year may better reflect the actual state of ELC implementation. Therefore, we use *ELC_N* as an alternative measure of ELC for robustness testing. Table 5 reports the results of regression analysis. The results in Table 5 provide additional evidence of the validity of the results.

<Insert Table 5 about here>

6.2. *Alternative Measure of CEI and logistic regression*

A dummy variable (CEI_DUM) was constructed to measure CEI. For firms whose number of environmental patent applications in a given year is greater than 0, the value of CEI_DUM is 1; otherwise, it is 0. The use of logistic regression is appropriate in this case. Table 6 reports the logistic regression results, from which it is evident that the estimated coefficients of ELC and the two interaction terms ($ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$ and $ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$) are significantly positive. Therefore, the logistic regression results support the proposed hypotheses.

<Insert Table 6 about here>

6.3. *Tobit regression*

Because 65.69% of the observations of the dependent variable are zero and cannot be negative, Tobit regression was used for model estimation (Bu et al., 2020; Cho et al., 2006; Russo & Harrison, 2005). Table 7 reports the results of Tobit regression, which are consistent with the results reported in Table 4. Therefore, the hypotheses are supported by Tobit regression.

<Insert Table 7 about here>

6.4. *Multilevel Regression*

As the dataset used in this study has multiple nested structures, firms are embedded at the regional level; ELC, CEI and corporate ownership are embedded at the firm level; and local government intervention is embedded at the regional level. Therefore, we construct multilevel mixed-effects linear models (also known as hierarchical linear models (HLMs) or nested data models) and use multilevel techniques to regress the data. The model used for the analysis of multilevel nested data is estimated by the maximum likelihood method. We identify the existence of multilevel nested data by allowing for random effects at each level (Snijders & Bosker, 2012). As shown in Table 8, the estimated coefficients of ELC and the two interaction terms ($ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$ and $ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$) in Models 1-4 are basically consistent, and the results of the multilevel regression support our hypotheses.

<Insert Table 8 about here>

6.5. *Additional Analysis*

Returns on investment from environmental innovation materialize over a longer period of time (Arena et al., 2018). This shows that the positive effects of ELC on CEI emerge over the long term. Therefore, we further lag *ELC*, *OWN*, and *LGI* by two years and regress the models again to examine the long-term effects of ELC on CEI and whether corporate ownership and local government intervention also have long-term moderating effects.

As shown in Table 9, the estimated coefficients of $ELC_{i,t\text{-}2}$ in Model 1 are significantly positive, indicating that ELC has a long-term positive impact on CEI. In Model 2, the estimated coefficient of the interaction term ($ELC_{i,t\text{-}2}*OWN_{i,t\text{-}2}$) is significantly positive, indicating that the ELC of non-SOEs has a stronger long-term effect on CEI than on SOEs. Therefore, our results support a long-term moderating effect of corporate ownership. In Model 3, the estimated coefficient of the interaction term ($ELC_{i,t\text{-}2}*LGI_{i,t\text{-}2}$) is significantly positive, indicating that the ELC of firms in a region with low levels of government intervention has a stronger long-term effect on CEI than that of firms in regions with high levels of government intervention. Therefore, our results support the long-term moderating role of local government intervention in the effect of ELC on CEI. This provides stronger evidence for the robustness of our results.

<Insert Table 9 about here>

7. Endogeneity

While lagging variables by a period can control for possible simultaneity bias (Rong et al., 2017), the results of this study may be biased due to potential endogeneity problems. One source of potential endogeneity is reverse causality, *i.e.*, listed firms with strong innovation capacities are more likely to apply for ELC. Another source of potential endogeneity pertains to missing variables (e.g., government environmental subsidies), which may affect the possibility of ELC and CEI.

To eliminate estimation coefficient bias caused by potential endogeneity, the traditional instrumental variable (IV) and heteroscedasticity-based IV are used. After an extensive search, we introduce the ELC proportion of other firms in the industry as the traditional IV for the ELC of listed firms. According to institutional theory, the behavior of listed firms is affected by isomorphic mimetic pressure from other firms in the industry (DiMaggio & Powell, 1983), and listed firms may tend to copy the behaviors of more successful or legitimate organizations. Therefore, the implementation of ELC for listed firms is likely to be affected by other firms in the industry. In addition, the ELC proportion of other firms in the industry is unlikely to directly affect the environmental innovation of a listed firm. From this perspective, the ELC proportion of other firms in the industry satisfies both relevance and exogenous (also known as the exclusion restriction) conditions of the traditional IV.

Increasing the number of IVs usually produces more effective estimations. Therefore, we use the heteroscedasticity-based instruments proposed by Lewbel (2012). The Lewbel (2012) method does not rely on exclusive constraints but exploits heteroscedasticity for identification.

When no traditional instruments are available, Lewbel (2012) IV (LIV) serves as an alternative. Moreover, when traditional exogenous IVs are weak, LIV can be used to supplement traditional instruments to improve the efficiency of IV estimation. This method has been widely used in academic research (e.g., Emran & Hou, 2013; Millimet & Roy, 2016).

We record the exogenous variable as $\boldsymbol{Z}$, which can be a subset of $\boldsymbol{X}$, or even Z=$\boldsymbol{X}$. The estimation of LIV involves the following two steps. First, each endogenous variable is regressed on the $\boldsymbol{Z}$ vector by OLS regression, and the vector of residuals $\hat{\boldsymbol{\varepsilon}}$ is retrieved. Second, dependent variable $\boldsymbol{Y}$ is regressed on the $\boldsymbol{X}$ vector and on endogenous variables using $(\boldsymbol{Z} - \overline{\boldsymbol{Z}})\,\hat{\boldsymbol{\varepsilon}}$ as instruments by 2SLS regression, where $\overline{\boldsymbol{Z}}$ is the mean of $\boldsymbol{Z}$ to obtain the estimated coefficient of endogenous variables. There are no accepted approaches for the optimal selection of $\boldsymbol{Z}$ (Mishra & Smyth, 2015). In this paper, the $\boldsymbol{Z}$ vector consists of firm age and size. Through testing, the IVs constructed meet the requirements of relevance and exclusion restrictions.

Since there are two endogenous interactions in the regression model, we process them according to the method developed by Rajan and Zingales (1998). As shown in Table 10, the results of IV estimation using the traditional and heteroscedasticity-based IV are reported. The Breusch and Pagan (1979) test rejects the null hypothesis of the same variance at a 1% significance level (test results are shown in the notes of Table 10), indicating that it is appropriate to construct IVs using the Lewbel (2012) method. The *Kleibergen-Paap rk LM statistic* rejects the null hypothesis of underidentification at a significance level of 1%, indicating that the IVs are related to ELC and satisfy the relevance condition. According to

Shea's partial R^2, the IVs also have excellent explanatory power (the lowest value of *Shea's partial* R^2 is 0.2698). The *Anderson-Rubin F-test* rejects the null hypothesis that the regression coefficients of endogenous explanatory variables are equal to zero at the 1% significance level. In addition, the *minimum eigenvalue statistic* is much larger than 16.10 (the critical value for the weak instrument test based on Two Stage Least Square bias) at a significance level of 5% (Stock & Yogo, 2005), which rejects the null hypothesis of weak instrumental variables. These results provide very strong evidence that the set of IVs is strongly correlated with endogenous explanatory variables and that we do not need to worry about weak IV issues. The *Hansen J statistic* cannot reject the null hypothesis of overidentification, indicating that the set of IVs is not related to the error term and satisfies the exogenous condition (*i.e.*, exclusion restriction). These tests show that the instruments are valid.

<Insert Table 10 about here>

As shown in Table 10, heteroscedasticity-robust standard errors clustered by firm are given in parentheses. Therefore, the estimated results are more reliable than those obtained when assuming an error term with the same variance. Model 1 shows the results of two-stage least squares (TSLS/2SLS) estimation. Model 2 shows the results of the generalized method of moments (GMM) estimation. Model 3 reports the results of the limited-information maximum likelihood (LIML) estimation. When there are weak IVs, the finite-sample property of the LIML estimator is better than that of 2SLS and GMM (Baum et al., 2007). In Models 1-3, the estimated coefficients of $ELC_{i,t\text{-}1}$ and the interaction terms ($ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$ and $ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$) are significantly positive. This shows that after eliminating potential endogeneity, the empirical results still support our hypotheses, and the conclusions obtained from this study are robust and reliable.

8. Discussion and Conclusion

Our research aimed to explore how ELC affects CEI and how corporate ownership and local government intervention adjust the relationship between them. For a sample of A-share listed manufacturing firms in China from 2008 to 2014, we found that ELC was positively associated with CEI. Moreover, the positive impact of ELC on CEI was stronger for non-SOEs than for SOEs, and it was also stronger for firms in regions with low government intervention than for those in regions with high government intervention.

8.1. *Theoretical Contributions*

The theoretical contributions of this study are mainly reflected in the following three aspects. First, this study sought to advance the theoretical linkage between ELC and CEI under a new theoretical framework combining legitimacy theory and the resource management perspective. While CEI is affected by the combined effects of external and internal factors, previous studies have explored the determinants of CEI via the use of institutional theory, legitimacy theory, and stakeholder theory from an external perspective (Berrone et al., 2013; Zhang & Zhu, 2019; Zhou et al., 2021) or via the use of the RBV from an internal perspective (Chang, 2011; Li et al., 2019; Lin et al., 2014; Wagner, 2007). However, how ELC affects CEI remains unclear. This study provides new insights that help clarify the relationship between ELC and CEI in consideration of both the external and internal perspectives via the combination of legitimacy theory and the resource management perspective. The results of this study demonstrate that ELC improves CEI, thereby confirming the arguments based on legitimacy theory and the resource management perspective. In other words, ELC improves CEI by enhancing firms' motivation for environmental innovation, promoting resource acquisition, and improving resource utilization efficiency. However, the underlying mechanisms in the relationship between ELC and CEI differ from those in the relationships between other VERs (i.e., ISO 14001 certification and voluntary environmental disclosure) and CEI. ISO 1400 certification is found to positively affect CEI by facilitating the generation of strategic knowledge, resources, and capabilities (Li et al., 2019). Voluntary environmental information disclosure is the pressure source that propels CEI (Yin & Wang, 2018). Therefore, this study extends the understanding of the impacts of VERs with different characteristics on CEI. This study also contributes to the understanding of the process of legitimation through which certified firms act to increase their legitimacy by considering the process of gaining and maintaining the legitimacy of certified firms. Moreover, this study demonstrates that legitimacy theory and the resource management perspective are complementary. Few studies have combined these important methods. Their merger helps reveal new connections that have not been discovered thus far and deepens the understanding of the roles that ELC plays in promoting CEI.

Second, this study provides the boundary conditions of how ELC affects CEI. The institutional context will strengthen or weaken the relationships between VERs and CEI. However, the extant research has remained silent on which contextual factors moderate the relationship between ELC and CEI. By investigating the moderating effects of two contextual factors (i.e., corporate ownership and local government intervention), this study fills this gap and helps to untangle the complex relationship between ELC and CEI. The results demonstrate that ELC better stimulates CEI in non-SOEs than in SOEs, and local government intervention weakens ELC's promotion of CEI. Therefore, the impact of ELC on CEI varies not only with the type of corporate ownership but also with the degree of local government intervention in the region in which the firm is located. Different from the literature that regards corporate ownership and local government intervention as antecedents of CEI (He & Jiang, 2019; Hu et al., 2021; Joo et al., 2018), this study also extends the current understanding of the roles of corporate ownership and local government intervention by considering them crucial moderators in the relationship between ELC and CEI.

Third, this study also contributes to the ongoing debate regarding the effectiveness of VERs in developing countries, which remains unresolved and involves two opposing views. The first viewpoint supports the notion that VERs hold considerable promise for developing countries (Bu et al., 2020; Hanks, 2002; Reconstruction & Development, 2000). The second viewpoint holds that VERs are not effective in developing countries because of weak regulatory pressure and weak nonregulatory pressure from consumers, capital markets, environmental NGOs, community groups, etc. (Blackman, 2008). In response to Tatoglu et al. (2020) and Wang et al. (2015), this study empirically examined the effectiveness of environmental labeling programs in China from the perspective of environmental innovation. The results indicate that ELC can improve CEI, which provides a new understanding of the benefits ELC brings to firms. Therefore, environmental labeling programs are quite promising in developing countries.

However, the results also indicate that the effectiveness of environmental labeling programs in developing countries is affected by contextual factors. Thus, this study also provides an important perspective that contributes to the debate on the effectiveness of VERs in developing countries.

8.2. *Practical implications*

First, the results have important implications for the future application of environmental labeling programs. Taking China's environmental labeling program as the empirical context, it was found that ELC significantly improves CEI. This provides a new understanding of the benefits ELC brings to firms. The principles and procedures of environmental labeling programs worldwide comply with the ISO 14024 standard, and the international mutual recognition of environmental labeling is an inevitable development trend. As the world's largest developing country, China shares many common features with other developing countries, such as diversified corporate ownership, widespread local government intervention, and prominent environmental problems. Therefore, the results of this study can be generalized to other countries, especially developing countries, encouraging them to adopt and promote environmental labeling programs. However, it is necessary to consider the impacts of contextual factors, such as corporate ownership and local government intervention, during the implementation process.

Second, the results provide important policy implications for policy-makers. Traditional environmental regulations are costly to implement and may also curb corporate innovation. However, VERs give firms more autonomy and flexibility (Jiang et al., 2020); thus, they are favored by policy-makers. The results suggest that policy-makers should encourage third-party institutions to research, develop and implement environmental standards for more product categories. Moreover, policy-makers should formulate and implement supportive policies (e.g., priority purchasing of ELC products in the public procurement process and the subsidization of certification fees) to encourage more firms to engage in environmental labeling programs. In this case, more firms will participate in environmental labeling programs and improve their environmental innovation performance. Furthermore, policy-makers should support the development of private enterprises and a mixed-ownership economy and persist in promoting the reform of SOEs. For example, policy-makers should create a business environment that is nondiscriminatory, which offers fair competition for firms of all types of ownership, solves the problem of financing and loan difficulties for non-SOEs and allows non-SOEs to enjoy the same "national treatment" as SOEs. Simultaneously, policy-makers should properly handle the relationship between the government and the market. Specifically, they can reduce government intervention in the market in three ways: a) by reducing governmental intervention in resource allocation and relying more on market mechanisms to manage resource allocation while placing the market in a dominant position in the process of resource allocation; b) by simplifying the administrative approval process and reducing government interference in firms; and c) by streamlining government agencies and reducing government size.

Finally, the results provide important management implications for firm managers. Firms can use ELC as a tool to improve environmental legitimacy (Li et al., 2017), thereby improving relations with stakeholders and obtaining external resources (Bansal, 2005; Berrone & Gomez-

Mejia, 2009). Moreover, ELC forces firms to change their internal resource management practices and comprehensively improve their resource utilization efficiency through product environmental standards and product functional characteristics. As a result, ELC promotes CEI and enhances firms' competitive advantage. Therefore, firm managers are advised to actively certify environmental labeling for products and to produce products in strict compliance with product environmental standards and product functional characteristics to promote environmental innovation and improve competitive advantages. The findings of this study indicate that compared with SOEs, ELC has a stronger role in promoting environmental innovation in non-SOEs. Therefore, it is suggested that SOE managers pay more attention to the market and efficiency. In this way, SOEs can better leverage the role of ELC in promoting CEI.

8.3. *Limitations and Avenues for Future Research*

While this study has several insightful implications, it is not without limitations, revealing opportunities for future research. First, our research sample is limited to A-share listed manufacturing firms in China. Due to the limited availability of data, we mainly studied listed firms with relatively transparent data, and it was impossible to include other non-listed manufacturing firms. Follow-up studies can use different empirical samples to further verify the generalizability of the findings. Second, only two typical contextual factors, i.e., corporate ownership and local government intervention, were used to investigate the moderating effect. However, it is reasonable to assume that other contextual factors, such as the intensity of industry competition and the strength of local intellectual property protection, may also influence the impact of ELC on CEI. Future research can explore other contextual factors to provide a more nuanced understanding of the relationship between the two. Third, this study focused on the world's largest emerging market——China. However, due to substantial differences between developing and developed economies, the impact of ELC on CEI and its contextual factors may differ between these two types of economies. This calls for further research that can explore how and why ELC affects CEI in developed economies.

1 **Footnote**

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① The Global Ecolabeling Network (GEN) is a nonprofit association of leading ecolabeling organizations worldwide. GEN was founded in 1994 to help protect the environment by improving, promoting, and developing the ecolabeling of green products and sustainable services. Please see the website for details: https://www.globalecolabelling.net/about/gen-the-global-ecolabelling-network/.

② The China Environmental United Certification Center (CEC) is the most professional and authoritative institute on Chinese environment certification. As a certification institute mainly focused on environmental protection, energy saving and climate protection, the CEC works as a third-party institute and provides just certification services for social groups. For further details, see http://www.mepcec.com/.

③ The Hongqi H5 Sedan has been certified by China Environmental Labelling: https://mp.weixin.qq.com/s/a2rX_FCUBO410K68sIEkdQ.

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Tables and Figures

Table 1 Similarities and differences between the three types of VERs

	ISO 14001 certification	Voluntary environmental disclosure	ELC
Auditors	Third-party	First-party	Third-party
objects	Any firms	Specific firms	Specific products
methods	Process-based	Environmental information-based	Product-based
standards	ISO 14001 standard	——	ISO 14024 standard
Objectives	Intended outcomes	Addressing stakeholder concerns about the environment	A reduction in the environmental impacts associated with products

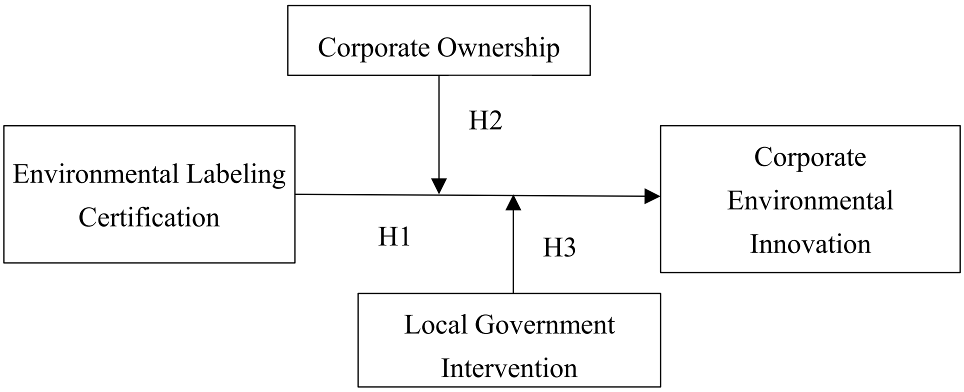

Figure 1. Concept model with hypotheses

Table 2 Sample distribution of certified firms by industry (2014)

Industry Code	Industry Name	No. of Unlabelled Firms	No. of Labelled Firms	Total No. of Firms	% of Labelled Firms
C13	Processing of Food from Agricultural Products	34	0	34	0.00%
C14	Manufacture of Foods	20	0	20	0.00%
C15	Manufacture of Liquor, Beverages and Refined Tea	27	1	28	3.57%
C16	Manufacture of Tobacco				
C17	Manufacture of Textiles	30	1	31	3.23%
C18	Manufacture of Textiles, Apparel and Accessories	14	1	15	6.67%
C19	Manufacture of Leather, Fur, Feather and Related Products and Footwear	6	0	6	0.00%
C20	Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products	0	6	6	100.00%
C21	Manufacture of Furniture	4	0	4	0.00%
C22	Manufacture of Paper and Paper Products	19	3	22	13.64%
C23	Printing and Reproduction of Recording Media	1	3	4	75.00%
C24	Manufacture of Articles for Culture, Education, Arts and Crafts, Sport and Entertainment Activities	2	2	4	50.00%
C25	Processing of Petroleum, Coking and Processing of Nuclear Fuel	18	0	18	0.00%
C26	Manufacture of Raw Chemical Materials and Chemical Products	123	5	128	3.91%
C27	Manufacture of Medicines	121	0	121	0.00%
C28	Manufacture of Chemical Fibres	20	1	21	4.76%
C29	Manufacture of Rubber and Plastic Products	25	9	34	26.47%
C30	Manufacture of Non-metallic Mineral Products	45	7	52	13.46%
C31	Smelting and Pressing of Ferrous Metals	23	0	23	0.00%
C32	Smelting and Pressing of Non-ferrous Metals	44	0	44	0.00%
C33	Manufacture of Metal Products	30	0	30	0.00%
C34	Manufacture of General Purpose Machinery	64	1	65	1.54%
C35	Manufacture of Special Purpose Machinery	118	0	118	0.00%
C36	Manufacture of Automobiles	52	10	62	16.13%
C37	Manufacture of Railway, Ship, Aerospace and Other Transport	22	1	23	4.35%

	Equipment				
C38	Manufacture of Electrical Machinery and Apparatuses	106	7	113	6.19%
C39	Manufacture of Computers and Communication and Other Electronic Equipment	132	9	141	6.38%
C40	Manufacture of Measuring Instruments and Machinery	14	1	15	6.67%
C41	Other Manufacturing	7	1	8	12.50%
	Total	1121	69	1190	5.80%

Note: The above industry classification standard is based on ‘*Guidelines for the Industry Classification of Listed Firms* (2012ed)’ promulgated by the China Securities Regulatory Commission.

Table 3 Descriptive statistics and Pearson correlations

No.	Variables	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12
1	*CEI*	0.47	0.76	0.00	5.77	1.000											
2	*ELC*	0.03	0.17	0.00	1.00	0.099***	1.000										
3	*OWN*	0.57	0.50	0.00	1.00	-0.034***	-0.015	1.000									
4	*LGI*	7.12	1.58	-6.75	9.65	0.036***	-0.004	0.170***	1.000								
5	*AGE*	13.77	5.09	1.01	39.53	-0.013	0.060***	-0.200***	-0.071***	1.000							
6	*SIZE*	21.63	1.13	16.70	26.75	0.261***	0.126***	-0.295***	-0.110***	0.149***	1.000						
7	*ROA*	0.04	0.28	-6.71	20.79	0.028**	0.002	0.052***	0.017	-0.030**	0.001	1.000					
8	*LEV*	0.47	1.34	0.01	96.96	0.039***	0.001	-0.035***	-0.008	0.056***	-0.041***	-0.241***	1.000				
9	*R&D*	0.01	0.02	0.00	0.22	0.147***	0.014	0.178***	0.095***	-0.113***	-0.084***	0.041***	-0.068***	1.000			
10	*EMSC*	0.49	0.50	0.00	1.00	0.271***	0.082***	0.061***	0.102***	-0.103***	0.168***	0.015	-0.039***	0.190***	1.000		
11	*QMSC*	0.61	0.49	0.00	1.00	0.178***	0.056***	0.037***	0.073***	-0.088***	0.075***	0.002	-0.050***	0.166***	0.404***	1.000	
12	*ETS*	0.35	0.48	0.00	1.00	0.039***	-0.025**	0.122***	0.122***	-0.009	0.008	-0.003	-0.025**	0.072***	0.129***	0.091***	1.000

Note: Observations *N*=7099. *, **, and *** indicate significance at the 10%, 5%, and 1% or lower levels, respectively.

Table 4 Regression analysis results

Variables	Model 1	Model 2	Model 3	Model 4
$ELC_{i,t\text{-}1}$	0.494***	0.637***	0.582***	0.661***
	(0.145)	(0.130)	(0.127)	(0.128)
$OWN_{i,t\text{-}1}$	0.012	0.015	0.008	0.011
	(0.039)	(0.038)	(0.038)	(0.038)
$LGI_{i,t\text{-}1}$	0.036	0.034	0.035	0.034
	(0.024)	(0.024)	(0.024)	(0.024)
$ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$		0.062***		0.046***
		(0.017)		(0.016)
$ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$			0.072***	0.049***
			(0.016)	(0.015)
$AGE_{i,t\text{-}1}$	-0.004	-0.004	-0.004	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)
$SIZE_{i,t\text{-}1}$	0.157***	0.158***	0.156***	0.157***
	(0.021)	(0.021)	(0.021)	(0.021)
$ROA_{i,t\text{-}1}$	0.130***	0.130***	0.130***	0.130***
	(0.010)	(0.010)	(0.010)	(0.010)
$LEV_{i,t\text{-}1}$	0.052***	0.052***	0.052***	0.052***
	(0.003)	(0.003)	(0.003)	(0.003)
$R\&D_{i,t\text{-}1}$	2.431**	2.342**	2.474**	2.394**
	(1.095)	(1.086)	(1.094)	(1.087)
$EMSC_{i,t\text{-}1}$	0.266***	0.266***	0.263***	0.264***
	(0.035)	(0.035)	(0.035)	(0.035)
$QMSC_{i,t\text{-}1}$	0.096***	0.095***	0.095***	0.095***
	(0.033)	(0.033)	(0.033)	(0.033)
$ETS_{i,t\text{-}1}$	-0.021	-0.022	-0.022	-0.022
	(0.043)	(0.043)	(0.043)	(0.043)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
Constant	-3.488***	-3.485***	-3.458***	-3.466***
	(0.526)	(0.520)	(0.522)	(0.519)
Number of observations	5,821	5,821	5,821	5,821
F statistic	18.32	18.78	18.55	18.58
R^2	0.184	0.191	0.190	0.193
Adjusted R^2	0.174	0.180	0.179	0.182

Note: Standard errors clustered by firm are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% or lower levels, respectively.

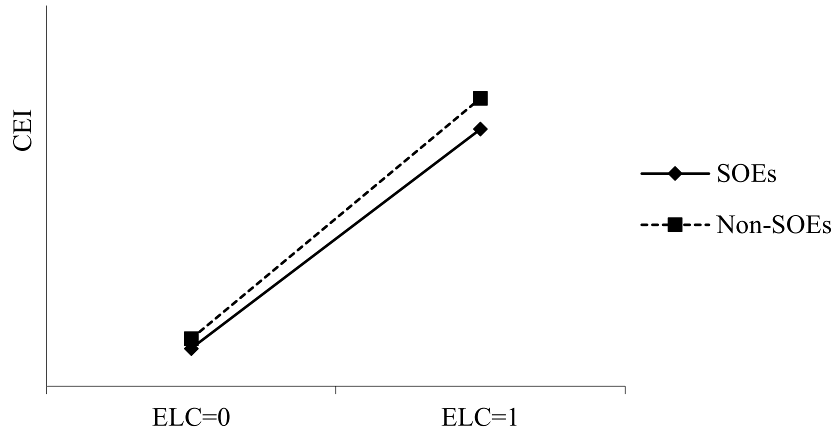

Figure 2. The moderating effect of corporate ownership on the relationship between ELC and CEI

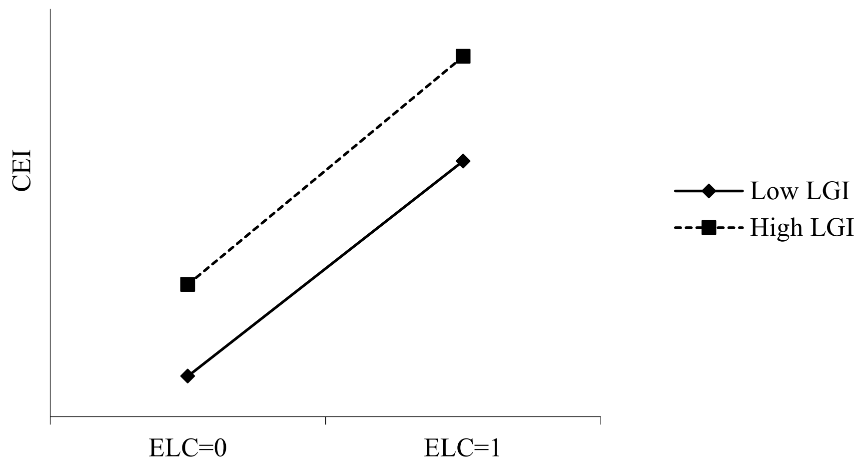

Figure 3. The moderating effect of local government intervention on the relationship between ELC and CEI

Table 5 Results of the regression with an alternative measure of ELC

Variables	Model 1	Model 2	Model 3	Model 4
$ELC\_N_{i,t\text{-}1}$	0.085***	0.111***	0.105***	0.131***
	(0.018)	(0.017)	(0.025)	(0.021)
$OWN_{i,t\text{-}1}$	0.012	0.012	0.011	0.012
	(0.039)	(0.039)	(0.039)	(0.038)
$LGI_{i,t\text{-}1}$	0.036	0.036	0.036	0.037
	(0.025)	(0.025)	(0.024)	(0.024)
$ELC\_N_{i,t\text{-}1}*OWN_{i,t\text{-}1}$		0.045***		0.046***
		(0.013)		(0.011)
$ELC\_N_{i,t\text{-}1}*LGI_{i,t\text{-}1}$			0.094**	0.096**
			(0.043)	(0.043)
$AGE_{i,t\text{-}1}$	-0.003	-0.004	-0.004	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)
$SIZE_{i,t\text{-}1}$	0.160***	0.161***	0.160***	0.160***
	(0.021)	(0.021)	(0.021)	(0.021)
$ROA_{i,t\text{-}1}$	0.130***	0.130***	0.130***	0.131***
	(0.010)	(0.010)	(0.010)	(0.010)
$LEV_{i,t\text{-}1}$	0.052***	0.052***	0.052***	0.052***
	(0.003)	(0.003)	(0.003)	(0.003)
$R\&D_{i,t\text{-}1}$	2.330**	2.231**	2.365**	2.265**
	(1.091)	(1.087)	(1.091)	(1.086)
$EMSC_{i,t\text{-}1}$	0.265***	0.263***	0.264***	0.263***
	(0.035)	(0.035)	(0.035)	(0.035)
$QMSC_{i,t\text{-}1}$	0.097***	0.096***	0.096***	0.096***
	(0.033)	(0.033)	(0.033)	(0.033)
$ETS_{i,t\text{-}1}$	-0.022	-0.021	-0.024	-0.022
	(0.043)	(0.043)	(0.043)	(0.043)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
Constant	-3.582***	-3.590***	-3.571***	-3.579***
	(0.529)	(0.525)	(0.525)	(0.522)
Number of observations	5,821	5,821	5,821	5,821
F statistic	18.50	19.23	18.34	20.24
R^2	0.186	0.189	0.188	0.191
Adjusted R^2	0.175	0.178	0.177	0.180

Note: Standard errors clustered by firm are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% or lower levels, respectively.

Table 6 Results of logistic regression

Variables	Model 1	Model 2	Model 3	Model 4
$ELC_{i,t\text{-}1}$	1.458***	10.264***	2.348***	10.453***
	(0.432)	(0.571)	(0.537)	(0.574)
$OWN_{i,t\text{-}1}$	0.032	0.328***	0.025	0.310***
	(0.118)	(0.119)	(0.118)	(0.118)
$LGI_{i,t\text{-}1}$	0.176**	0.170**	0.177**	0.171**
	(0.086)	(0.086)	(0.087)	(0.086)
$ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$		1.175***		1.103***
		(0.064)		(0.062)
$ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$			0.280***	0.219**
			(0.092)	(0.098)
$AGE_{i,t\text{-}1}$	-0.018*	-0.018*	-0.019*	-0.019*
	(0.010)	(0.010)	(0.010)	(0.010)
$SIZE_{i,t\text{-}1}$	0.362***	0.364***	0.362***	0.363***
	(0.054)	(0.054)	(0.055)	(0.055)
$ROA_{i,t\text{-}1}$	0.313**	0.313**	0.311**	0.313**
	(0.153)	(0.149)	(0.146)	(0.147)
$LEV_{i,t\text{-}1}$	0.124*	0.125*	0.125*	0.126*
	(0.066)	(0.066)	(0.067)	(0.067)
$R\&D_{i,t\text{-}1}$	3.898	3.738	4.005	3.827
	(3.103)	(3.104)	(3.114)	(3.114)
$EMSC_{i,t\text{-}1}$	0.820***	0.819***	0.818***	0.819***
	(0.103)	(0.103)	(0.104)	(0.104)
$QMSC_{i,t\text{-}1}$	0.445***	0.447***	0.445***	0.446***
	(0.104)	(0.104)	(0.105)	(0.105)
$ETS_{i,t\text{-}1}$	-0.125	-0.125	-0.131	-0.134
	(0.144)	(0.145)	(0.144)	(0.145)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
Constant	-11.023***	-11.199***	-11.050***	-11.180***
	(1.405)	(1.410)	(1.418)	(1.417)
Number of observations	5821	5821	5821	5821
Log pseudolikelihood	-3305.1914	-3287.4273	-3289.6184	-3279.2525
Wald χ^2 *statistics*	407.02	1497.72	404.75	1341.03
Pseudo R2	0.1284	0.1331	0.1325	0.1353

Note: Robust standard errors are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% or lower levels, respectively.

Table 7 Results of Tobit regression

Variables	Model 1	Model 2	Model 3	Model 4
$ELC_{i,t\text{-}1}$	0.494***	0.637***	0.582***	0.661***
	(0.145)	(0.129)	(0.126)	(0.127)
$OWN_{i,t\text{-}1}$	0.012	0.015	0.008	0.011
	(0.038)	(0.038)	(0.038)	(0.038)
$LGI_{i,t\text{-}1}$	0.036	0.034	0.035	0.034
	(0.024)	(0.024)	(0.024)	(0.024)
$ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$		0.062***		0.046***
		(0.017)		(0.016)
$ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$			0.072***	0.049***
			(0.016)	(0.015)
$AGE_{i,t\text{-}1}$	-0.004	-0.004	-0.004	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)
$SIZE_{i,t\text{-}1}$	0.157***	0.158***	0.156***	0.157***
	(0.021)	(0.021)	(0.021)	(0.021)
$ROA_{i,t\text{-}1}$	0.130***	0.130***	0.130***	0.130***
	(0.010)	(0.010)	(0.010)	(0.010)
$LEV_{i,t\text{-}1}$	0.052***	0.052***	0.052***	0.052***
	(0.003)	(0.003)	(0.003)	(0.003)
$R\&D_{i,t\text{-}1}$	2.431**	2.342**	2.474**	2.394**
	(1.088)	(1.080)	(1.087)	(1.080)
$EMSC_{i,t\text{-}1}$	0.266***	0.266***	0.263***	0.264***
	(0.035)	(0.035)	(0.035)	(0.035)
$QMSC_{i,t\text{-}1}$	0.096***	0.095***	0.095***	0.095***
	(0.033)	(0.033)	(0.033)	(0.033)
$ETS_{i,t\text{-}1}$	-0.021	-0.022	-0.022	-0.022
	(0.042)	(0.042)	(0.042)	(0.042)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
Constant	-3.488***	-3.486***	-3.458***	-3.466***
	(0.523)	(0.516)	(0.519)	(0.515)
Number of observations	5821	5821	5821	5821
Log pseudolikelihood	-6063.1967	-6041.081	-6043.6653	-6033.2876
F statistics	18.55	19.02	18.79	18.82
Pseudo R2	0.0891	0.0924	0.0920	0.0936

Note: Robust standard errors are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% or lower levels, respectively.

Table 8 Results of the multilevel regression

Variables	Model 1	Model 2	Model 3	Model 4
$ELC_{i,t-1}$	0.442***	0.535***	0.494***	0.552***
	(0.121)	(0.110)	(0.115)	(0.113)
$OWN_{i,t-1}$	0.018	0.024	0.017	0.022
	(0.034)	(0.034)	(0.034)	(0.035)
$LGI_{i,t-1}$	0.004	0.004	0.006	0.005
	(0.008)	(0.008)	(0.008)	(0.008)
$ELC_{i,t-1}*OWN_{i,t-1}$		0.042***		0.033**
		(0.012)		(0.013)
$ELC_{i,t-1}*LGI_{i,t-1}$			0.037***	0.025**
			(0.013)	(0.013)
$AGE_{i,t-1}$	-0.003	-0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)
$SIZE_{i,t-1}$	0.155***	0.156***	0.155***	0.156***
	(0.019)	(0.019)	(0.019)	(0.019)
$ROA_{i,t-1}$	0.067***	0.067***	0.067***	0.067***
	(0.009)	(0.009)	(0.009)	(0.009)
$LEV_{i,t-1}$	0.025***	0.025***	0.025***	0.025***
	(0.002)	(0.002)	(0.002)	(0.002)
$R\&D_{i,t-1}$	1.898***	1.894***	1.950***	1.931***
	(0.589)	(0.585)	(0.586)	(0.585)
$EMSC_{i,t-1}$	0.169***	0.169***	0.169***	0.169***
	(0.029)	(0.029)	(0.029)	(0.029)
$QMSC_{i,t-1}$	0.104***	0.103***	0.103***	0.103***
	(0.028)	(0.027)	(0.028)	(0.027)
$ETS_{i,t-1}$	-0.003	-0.003	-0.002	-0.002
	(0.031)	(0.032)	(0.031)	(0.031)
Industry dummies	Yes	Yes	Yes	Yes
Constant	-3.218***	-3.239***	-3.233***	-3.242***
	(0.447)	(0.449)	(0.446)	(0.447)
Number of observations	5821	5821	5821	5821
ICC at the region level	0.0013	0.0017	0.0010	0.0014
ICC at the firm level	0.5323	0.5317	0.5320	0.5315

Note: ICC is the intraclass correlation coefficient. Standard errors clustered by region are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% or lower levels, respectively.

Table 9 Results of the additional analysis

Variables	Model 1	Model 2	Model 3	Model 4
$ELC_{i,t\text{-}2}$	0.358***	0.396***	0.408***	0.425***
	(0.137)	(0.131)	(0.130)	(0.128)
$OWN_{i,t\text{-}2}$	-0.011	-0.009	-0.012	-0.011
	(0.041)	(0.041)	(0.041)	(0.041)
$LGI_{i,t\text{-}2}$	0.027	0.026	0.025	0.024
	(0.029)	(0.029)	(0.029)	(0.029)
$ELC_{i,t\text{-}2}*OWN_{i,t\text{-}2}$		0.042**		0.031*
		(0.018)		(0.018)
$ELC_{i,t\text{-}2}*LGI_{i,t\text{-}2}$			0.053***	0.042***
			(0.015)	(0.016)
$AGE_{i,t\text{-}2}$	-0.005	-0.005	-0.005	-0.005
	(0.004)	(0.004)	(0.004)	(0.004)
$SIZE_{i,t\text{-}2}$	0.172***	0.173***	0.172***	0.173***
	(0.024)	(0.023)	(0.023)	(0.023)
$ROA_{i,t\text{-}2}$	0.128***	0.128***	0.128***	0.128***
	(0.010)	(0.010)	(0.010)	(0.010)
$LEV_{i,t\text{-}2}$	0.056***	0.056***	0.056***	0.056***
	(0.002)	(0.002)	(0.002)	(0.002)
$R\&D_{i,t\text{-}2}$	1.957	1.944	1.956	1.947
	(1.210)	(1.208)	(1.208)	(1.207)
$EMSC_{i,t\text{-}2}$	0.272***	0.271***	0.270***	0.270***
	(0.039)	(0.039)	(0.039)	(0.039)
$QMSC_{i,t\text{-}2}$	0.076**	0.077**	0.078**	0.078**
	(0.036)	(0.036)	(0.036)	(0.036)
$ETS_{i,t\text{-}2}$	0.026	0.027	0.026	0.027
	(0.044)	(0.044)	(0.044)	(0.044)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
Constant	-3.629***	-3.633***	-3.620***	-3.625***
	(0.592)	(0.588)	(0.590)	(0.588)
Number of observations	4,638	4,638	4,638	4,638
F statistic	17.84	17.77	17.71	17.56
R^2	0.185	0.188	0.188	0.189
Adjusted R^2	0.172	0.175	0.175	0.176

Note: Standard errors clustered by firm are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% or lower levels, respectively.

Table 10 Results of IV estimation

Variables	Model 1	Model 2	Model 3
	2SLS	GMM	LMIL
$ELC_{i,t\text{-}1}$	1.025***	0.994***	1.028***
	(0.279)	(0.239)	(0.280)
$OWN_{i,t\text{-}1}$	0.010	0.012	0.010
	(0.038)	(0.038)	(0.038)
$LGI_{i,t\text{-}1}$	0.030	0.033	0.030
	(0.025)	(0.024)	(0.025)
$ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$	0.101***	0.115***	0.101***
	(0.031)	(0.029)	(0.031)
$ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$	0.121***	0.119***	0.122***
	(0.036)	(0.033)	(0.036)
$AGE_{i,t\text{-}1}$	-0.005	-0.005	-0.005
	(0.003)	(0.003)	(0.003)
$SIZE_{i,t\text{-}1}$	0.155***	0.154***	0.155***
	(0.021)	(0.021)	(0.021)
$ROA_{i,t\text{-}1}$	0.130***	0.130***	0.130***
	(0.010)	(0.010)	(0.010)
$LEV_{i,t\text{-}1}$	0.052***	0.052***	0.052***
	(0.003)	(0.003)	(0.003)
$R\&D_{i,t\text{-}1}$	2.381**	2.408**	2.381**
	(1.078)	(1.077)	(1.078)
$EMSC_{i,t\text{-}1}$	0.260***	0.260***	0.260***
	(0.035)	(0.035)	(0.035)
$QMSC_{i,t\text{-}1}$	0.091***	0.088***	0.091***
	(0.033)	(0.033)	(0.033)
$ETS_{i,t\text{-}1}$	-0.022	-0.023	-0.022
	(0.043)	(0.043)	(0.043)
Year dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes
Constant	-3.254***	-3.243***	-3.253***
	(0.507)	(0.502)	(0.507)
Number of observations	5,821	5,821	5,821
Diagnostic tests for IV estimation			
Test for instrument underidentification			
Kleibergen-Paap rk LM statistic	12.15	12.15	12.15
P value	[0.0957]	[0.0957]	[0.0957]
Test for instrument relevance			
Anderson-Rubin F-test	10.20	10.20	10.20

P value	[0.0000]	[0.0000]	[0.0000]
Shea's partial R-squared			
$ELC_{i,t\text{-}1}$	0.3073	0.3073	0.3073
$ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$	0.4018	0.4018	0.4018
$ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$	0.2698	0.2698	0.2698
Minimum eigenvalue statistic	163.143	163.143	163.143
Test for instrument exogeneity			
Hansen J statistic	5.743	5.743	5.725
P value	[0.4526]	[0.4526]	[0.4547]

Note: Heteroskedasticity-robust standard errors clustered by firm are shown in parentheses. *P* values are shown in square brackets. *, **, and *** indicate significance at the 10%, 5%, and 1% or lower levels, respectively.

The test of heteroskedasticity for the first step of LIV estimator is as follows:

Dependent variable (1st step): Breusch-Pagan/Cook-Weisberg test for heteroskedasticity

$ELC_{i,t\text{-}1}$: chi2(1) =3363.15, P value=0.0000

$ELC_{i,t\text{-}1}*OWN_{i,t\text{-}1}$: chi2(1) =3056.84, P value=0.0000

$ELC_{i,t\text{-}1}*LGI_{i,t\text{-}1}$: chi2(1) = 5107.15, P value=0.0000