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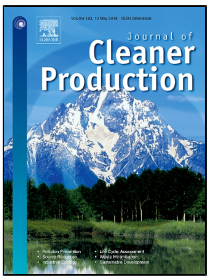

Does institutional pressure foster corporate green innovation? Evidence from China's top 100 companies

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Title Page

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Keywords:

Institutional pressure, coercive pressure, normative pressure, green innovation, organizational slack; Porter Hypothesis

Highlights:

The influence of institutional pressure on green innovation is explored.

The impact of organizational slack on the relationship between institutional pressure and

green innovation is studied.

Both normative pressure and coercive pressure significantly positively influences corporate green innovation.

Organizational slack positively moderates the relationship between coercive pressure and green innovation.

Does institutional pressure foster corporate green innovation? Evidence from China's top 100 companies

Abstract The value of green innovation on achieving sustainable development is increasingly recognized in recent years. This paper explores whether and how external institutional pressure (including coercive pressure, normative pressure and mimetic pressure, though the last was not discussed in depth) promote green innovation and investigates the moderating effect of internal organizational slack by combining institutional theory and resource-based view. With the sample of China's top 100 listed companies from 2008 to 2014 and generalized estimating equations (GEE) approach, the findings supports the Porter Hypothesis that both coercive pressure and normative pressure have significant positive effects on corporate green innovation. Organizational slack positively moderates the relationship between coercive pressure and green innovation, but has no significant impact on the relationship between normative pressure and green innovation. Accordingly, the scientific value of this research is that it extends the debates on Porter Hypothesis and the role of organizational slacks. The results suggest that the government should strengthen the implementation of coercive tools, the media should play roles of "muckraking", "catalyst" and the "vanguard" of public inquiry to insert normative pressure, and firms should rationally allocate slacks to improve green innovation.

Keywords Institutional pressure; coercive pressure; normative pressure; green innovation; organizational slack; Porter Hypothesis

1.Introduction

With environmental deterioration becoming one of the greatest challenge to the world, an increasing number of firms have been pressured to take green innovation initiatives to achieve both economic profits and environmental protection (Li et al., 2017). Green innovation refers to those innovations in mitigating the negative impact

of production and operations on the environment through improved processes, technologies, systems, products and management practices (Rennings, 2000; Kemp et al., 2008).

While there is plenty research on the value of green innovation (Doran et al., 2016), the reasons as to why some firms invest in more green innovation than others and under what conditions they pursue such innovation are under-explored, and how to effectively motivate green innovation among firms still needs more exploration (Berrone et al., 2013; Dangelico, 2016). Prior literature has investigated various external conditions (e.g., government environmental regulations, consumer green demand, competition pressure, etc.) as well as internal factors (e.g., technical competence, corporate profitability, environmental awareness of senior executives, etc.) in promoting green innovation (Cai and Zhou, 2014; Cainelli et al., 2015; Przychodzen et al., 2017).

Among these determinants, institutional pressure has been identified as an important driver of green innovation (Cai and Li, 2018; Porter and Van der Linde, 1995; Ramanathan et al., 2018). However, Eiadat et al. (2008) and Frondel et al. (2008) find that institutional pressure does not significantly affect green innovation. The inconsistency results into two different research streams: the conventional economic view held that institutional pressure is costly to firms, making them fall short of investment in green innovation (Frondel et al., 2008; Palmer et al., 1995). In contrast, a revisionist view, represented by Porter and colleagues, posited that environmental regulation could provide a potential incentive for firms to innovate,

which was known as the Porter Hypothesis (Cohen and Tubb, 2018; Ambec et al., 2013; Porter and Van der Linde, 1995).

The reasons of the inconsistency may be twofold. One reason is that institutional pressure is a complex concept comprised of different dimensions such as coercive pressure, normative pressure and mimetic pressure (Berrone et al., 2013; DiMaggio and Powell, 1983). However, current research seldom explore the impact of those specific dimensions. Another reason may be that the focal relationship is dependent on several boundary conditions, such as a firm's resources, ability, willingness, and industrial characteristics (Durand et al., 2017; Qi et al., 2010).

The inconsistency suggests that the dimensions and boundary conditions through which institutional pressure drives green innovation is still largely unclear. To fill in this gap, this research combines institutional theory and the resource-based view (RBV) to explore whether and how institutional pressure affects green innovation. Specifically, this research focuses on (1) the impacts of institutional pressure (as decomposed into coercive pressure and normative pressure) on corporate green innovation, (2) the moderating effect of organizational slack on the focal relationship.

This research makes several contributions to the literature. First, different from previous literature which studies the relationship between institutional pressure and green innovation in a general way, this study explores the dimensions of institutional pressure (coercive pressure and normative pressures) and their influence on green innovation, which helps extending the debate on the Porter Hypothesis. Second, by analyzing the moderating effect of organizational slack on how firms respond to

different institutional pressures, this research bridges the perspectives of institutional theory and RBV, which enriches the literature on the preconditions of green innovation and offers a holistic view of the drivers of green innovation that prior studies failed to obtain. It also echoes to current debate on whether slack is beneficial or detrimental for firms in the ecological context. Third, this study, situated in an emerging economy of China which is facing increasingly serious environmental problems with distinct political and economic characteristics, is of significant importance to test the generalizability of Western-based theories (Li et al., 2016).

2. Theoretical Framework and Hypotheses

2.1 Institutional Pressure and Corporate Green Innovation

Firms are inevitably bounded by the institutional environment in which they operate (DiMaggio and Powell, 1983). The institutional environment not only formulates and strengthens a firm's business philosophy, but also forces it to comply with external rules, norms and values (Oliver, 1991). Institutional theory holds that firms are committed to the pursuit of legitimacy, namely, the acceptance and approval of their institutional environment (Suchman, 1995), which has a significant impact and pressure on their organizational behavior (DiMaggio and Powell, 1983; Scott, 2005; Mignerat and Rivard, 2012).

Institutional pressures are mainly divided into three types: coercive pressure, normative pressure, and mimetic pressure (DiMaggio and Powell, 1983; Zhu and Sarkis, 2007). Coercive pressure originates from regulations formulated by

governmental agencies (Prajogo et al., 2012). Firms must comply with the laws and regulations to gain the legitimacy granted by the government. Normative pressure comes from customers and non-governmental organizations (Berrone et al., 2013). It mainly includes values and norms, and is closely related to satisfying social ethics standards (Zhang, 2015). Mimetic pressure originates from competitors (Daddi et al., 2016). In response to uncertainty in the business environment, firms recognize and imitate their competitors' behaviors to gain legitimacy (Li and Ding, 2013). Although the three types of institutional pressures are often at work simultaneously, they display varying degrees of effect and their correlation with green innovation is context-specific. Studies have shown that coercive agents (such as government agencies, etc.) and normative agents (such as non-governmental organizations, etc.) are relevant subjects that really affect corporate environmental behavior (Buysse and Verbeke, 2003; Kassinis and Vafeas, 2006). Scott (2005) also suggests that coercive and normative pressures deserve special attention from researchers, so this paper considers the impact of these two types of institutional pressure on green innovation (Berrone et al., 2013).

Green innovation aims to achieve pollution reduction through the development of new products, services, processes, and methods, thus reducing a firm's negative impact on the environment (Rennings, 2000; Brunnermeier and Cohen, 2003). An important feature of green innovation is its "dual externality": in addition to the positive externalities of all types of innovations by enabling improved knowledge diffusion (Roper et al., 2013), green innovation can benefit the society by promoting

energy and resource conservation, by implementing clean energy alternatives and by reducing waste emissions (Rennings, 2000; Li et al., 2017). With the dual externality, it is not enough to rely solely on the firms to voluntarily take green innovation initiatives, but requires the incentives and pressures from the government and other institutions. Thus, institutional theory provides a natural and proper perspective to analyze corporate green innovation (Phan et al.,2015; Zeng et al., 2017).

As for the effect of coercive pressure on green innovation, conventional economic scholars believe that government environmental regulation will increase the environmental costs of firms, augmenting financial pressure on corporate production processes (Amores-Salvadó, 2014) and thereby weakening firms' market competitiveness (Jaffe et al., 1995; Eiadat et al., 2008). But more research shows that proper and flexible environmental regulation will not only not harm corporate competitiveness, but will form "innovation offsets" and enhance competitive power, a phenomenon known as the "Porter Hypothesis" (Porter and van der Linde, 1995; Cai and Li, 2018; Ramanathan et al., 2018). Environmental regulation helps firms overcome organizational inertia, stay open to new ideas, stimulate creative thinking, and invest in green innovation activities such as clean technology improvements (Eiadat et al., 2008). Environmental regulation can be divided into command-control tools and market approaches (Ren et al., 2016). Command-control tools include market access, environmental standards, technical specifications, administrative penalties and other regulations and prohibitions (Zhao and Sun, 2016). Market approaches include emissions taxes, emissions trading, ecological compensation and

so on. Environmental regulation can create a stimulating effect of "carrot and stick" on firms. Menguc et al. (2010) showed that when the government strengthened supervision based on laws and regulations, strictly controlled pollutant discharge by coercive means, and imposed administrative and criminal punishments concurrently, firms would be more motivated to engage in environmental innovation to avoid both political and economic costs.

Different from coercive pressure, which is compulsory, normative pressure is comprised of soft constraints on firms (Zhu et al., 2016). In this form of pressure, moral standards and social norms guide firms to respect relevant environmental regulations, guidelines and engage in green innovation (Krell et al., 2016). Normative pressure stems mainly from customers, suppliers, media and the public and so on (Delgado-Ceballos et al. 2012; Zhu et al., 2016). In order to meet the environmental requirements of consumers (especially those from the international market), suppliers, and partners (Zhang et al., 2015), firms tend to take green innovative initiatives to improve their environmental performance (Zhang et al., 2008; Huang et al., 2016; Radnejad et al., 2017). Since stakeholders such as investors, customers, residents of the community, and the public often assess the legitimacy of the firms based on their cognition of those firms' environmental practices (Bansal and Clelland, 2004), media coverage is the main source for the public to obtain corporate environmental information, and thus the media can affect corporate green practices through guiding public cognition and evaluation. Based on this, this paper proposes the following hypotheses:

H1. Institutional pressure is positively related with corporate green innovation.

H1a. Coercive pressure is positively related with corporate green innovation.

H1b. Normative pressure is positively related with corporate green innovation.

2.2 The Moderating Role of Organizational Slack

Due to its high expenditure and unclear future benefit (Bin and Zhao, 2015), some firms may be reluctant to engage in green innovation, even when faced with strong institutional pressure. According to the resource-based view, a firm's behavior is determined by its resource base, and its response to institutional pressures depends on its resource adequacy (Barney, 1991; Li and Tang, 2010). Organizational slack, which is defined as additional resources that can be mobilized, and utilized beyond what is required, can serve as a buffer against shortages of funds and increase the potential for firm innovation (Bourgeois, 1981). Organizational slack provides more discretion for managers to engage in green innovation. Therefore, we explore the moderating effect of organizational slack on the relationship between institutional pressure and corporate green innovation.

Organizational slack is often regarded as actual or potential resources that play a buffer role in an organization and enable the organization to successfully cope with pressures caused by internal adjustments or external changes (Bourgeois, 1981; Lawson, 2001). It signifies the resources beyond the minimum required to produce given outputs (Geiger and Cashen, 2002). As green innovation is faced with risks of high capital investment, a long payback period and unclear financial returns (Ahuja et al., 2008; Scherer, 1999), the amount of organizational slack will have significant

influence on corporate green innovation investment when they are under external institutional pressures.

However, there is still inconsistency on whether these slacks are used by mangers to boost or dampen innovation. Agency theory highlights the perils of slack in the presence of managerial self-interest (Jensen, 1986). It is argued that, there is limited discipline over the selection and execution of projects as slack increases, resulting in inefficiency or even waste of corporate resources, which negatively affects corporate performance (Arena et al., 2017). Yet, a large stream of literature, especially the RBV, posits that organizational slack provides firms with the resources necessary to explore new opportunities, thus facilitates risk-taking and is beneficial for innovation. For instance, Cyert and March (1963) suggest that managers engage in more experimentation and innovation in the presence of slack. Arena et al. (2018) find that slack ensures investments in green innovation.

Therefore, we argue that organizational slack facilitate corporate risk-taking behavior and long-term orientation, and thus have a positive moderating effect on the relationship between institutional pressure and green innovation for the following reasons.

Slack enhances a firm's adaptability and buffers it from uncertainty (Cyert and March, 1963). Firms with abundant organizational slack have greater discretion and flexibility towards institutional pressure, since it has more repertoire of strategic choices, and can quickly and effectively respond to those pressures. For example, Berrone et al. (2013) find that, resource-abundant firms are more capable of investing

the necessary material, cash and talents to launch green products or processes in responding to external pressures. Also, high levels of slacks enable firms engage in risky initiatives when facing institutional pressures. Even if the green initiatives fail, organizational slack can still act as a buffer to some extent, mitigating the direct impact of failed projects on business performance (Keegan et al., 2002).

In contrast, firms with scarce organizational slack don't have enough freedom to respond to these pressures (Leonidou et al., 2013). They have to make full use of their scarce resources to tackle with the most immediate and pressing needs, thus results in neglecting environmental demands and reducing green innovation investments which is both risky and has a long-term horizon. Thus, the following hypotheses are proposed:

H2. Organizational slack positively moderates the relationship between institutional pressure and green innovation.

H2a. Organizational slack positively moderates the relationship between coercive pressure and green innovation.

H2b. Organizational slack positively moderates the relationship between normative pressure and green innovation.

3. Research design

3.1 Samples

This study selected the top 100 listed companies of China between 2008 and 2014 as its sample, which got initial 700 observations. The observations were

screened according to the following criteria: (1) excluding firms that issued B shares and/or H-shares for whose regulatory environments and financial characteristics are different (57 observations); (2) excluding special treatment (ST) firms due to their continuous loss-making over 2 years（5 observations）; (3) excluding firms that were listed in the Chinese stock market for less than one year (4 observations); (4) excluding firms whose listing was terminated (5 observations); (5) excluding firms in clean industries whose green innovation is not important and without any green patents (109 observations in finance industry, 22 observations in life insurance industry, 54 observations in real estate, 10 observations in tourism industry); (6) excluding companies with incomplete financial data (64 observations). After screening, we got a sample of 370 observations corresponding to 131 different enterprises. Table 1 shows the sample distribution by year and industry.

The data required in this research were obtained from China Stock Market & Accounting Research Database (CSMAR), annual reports of listed companies, China Core Newspapers Full-text Database (CCND), and the Baiteng patent network (http://so.5ipatent.com/).

Table 1 here

3.2 Measurements of variables

3.2.1 Dependent variable: green innovation

In previous studies, green innovation has been measured by indicators such as green R&D （Lee and Min, 2015）, eco-labeling product certification (Lin et al.,

2014), patents (Berrone et al., 2013) , ISO14001（Li et al., 2017）and so on. Considering the availability of data in China, green patent was employed as the indicator of green innovation (Brunnermeier and Cohen, 2003; Li et al., 2017) . Patents containing the Chinese keywords of "green", "low-carbon", "environmental", "energy-saving", "emissions reduction", "clean", "cycling", "saving", "sustainable", "ecology", "environmental pollution" and "environmental protection" are regarded as green patents (Brunnermeier et al., 2003; Li et al., 2016). We searched green invention patents for application and transformed the data applying its logarithm, due to the one-sample K-S test showed that the distribution of green invention patents was skewed ($P<0.01$). During this process, we added an extremely small number (+0.00000001) to manage the zero value, as previous statisticians have suggested (Hu, 1972). We also used all the three types of green application patents (patent for invention, patent of utility model and patent of appearance) as a robustness test.

3.2.2 Independent variables

Coercive pressure

The Marketization Index of Chinese provinces compiled by Chinese scholars Wang Xiaolu, Fan Gang and their colleagues is authoritative and widely used to measure coercive pressure (Wang et al. 2016). The Index ranges from 0-10 and is calculated through statistical data and survey data and composed of five indexes, i.e., the government-market relationship, development of non-state owned enterprises, development of product market, development of factor market, development of intermediates, laws and regulations to protect the market. The higher the score of a

province, the more coercive pressure a firm in the region faces. The annual amount of investment in government environmental pollution control at the provincial level was used for robustness test, as the governments' investment in pollution control reflects their efforts in regulation and enforcement.

Normative pressure

Normative pressure mainly comes from external stakeholders such as customers, investors, communities, industry associations and the social public (Berrone et al., 2013). Media coverage can largely reflect and guide the cognition and evaluation of the stakeholders, thus the extent of media coverage was applied to measure the level of normative pressure (Cormier and Magnan, 2015; Li et al., 2017).

The media reports are selected from the China Core Newspapers Full-text Database (CCND), an authoritative database developed by the China National Knowledge Infrastructure (CNKI), which covers more than 500 national and local newspapers. A total of 44,350 related media reports were selected and encoded (positive, neutral, and negative). A report was coded as positive if it contains positive environmental activities or impacts, such as environmental awards and recognition, pollution reduction and so on; while coded as negative if it is about a firm's environmental wrongdoings or losses; and neutral if it conveys no beneficial or detrimental environmental behavior or impacts. To ensure inter-coder reliability, the evaluation of media reports was first performed by one researcher, then by another. Any differences during the process were resolved by a third evaluator.

The Janis–Fadner coefficient was calculated to examine the imbalance in the

extent of media coverage (De Villiers and Van Staden, 2010; Li et al., 2017). The value of J–F coefficient ranges from -1 to 1; the reports are more favorable if the value is closer to 1, while less favorable if closer to -1. We used (1- J-F coefficient) to measure the pressure the media reports convey. The J-F coefficient is calculated by the following equation:

$$J-F\ Coefficient = \begin{cases} \dfrac{e^2-ec}{t^2}, & if\ e > c \\ 0, & if\ e = c \\ \dfrac{ec-c^2}{t^2}, & if\ e < c \end{cases}$$

where e represents the number of positive reports, c represents the number of negative reports, and t = e + c

3.2.3 Moderating variable: organizational slack

We adopted the logged value of the ratio of current assets to current liabilities to measure organizational slack (Bansal 2005; Walker et al.,2012), and the logarithm of firms'cash holding scaled by firms' market capitalization at year t −1 for robustness test (Tang et al., 2015).

3.2.4 Control variables

Corporate characteristics and governance would affect its investment behavior (Li et al., 2017). Accordingly, six variables including ownership, leadership structure, industry type, board independence, firm size, and growth were controlled in this study, whose measuring methods are concluded in Table 2.

Table 2 here

3.3 Model

To test the hypotheses, the following econometric models were constructed:

Main Effect Models:

$$GI_i = \alpha_0 + \alpha_1 NP_i + \alpha_2 CP_i + \alpha_3 Own_i + \alpha_4 LS_i + \alpha_5 Ind_i + \alpha_6 Indep_i + \alpha_7 Size_i + \alpha_8 Gro_i + \varepsilon_{1i}$$

Moderating Effect models:

$$GI_i = \beta_0 + \beta_1 NP_i + \beta_2 CP_i + \beta_3 OS_i + \beta_4 CP_i \times OS_i + \beta_5 NP_i \times OS_i + \beta_6 Own_i + \beta_7 LS_i + \beta_8 Ind_i + \beta_9 Size_i + \beta_{10} Indep_i + \beta_{11} Gro_i + \varepsilon_{2i}$$

where GI_i is the green innovation level of firm i; NP_i is the normative pressure; CP_i is the coercive pressure; OS_i is the organizational slack; Own_i is ownership; LS_i is leadership structure; Ind_i is industry type; $Indep_i$ is board independence; $Size_i$ is the scale of firm i; Gro_i is growth; α_0-α_8 are the coefficients; β_0-β_{11} are the coefficients; ε_{1i}, ε_{2i} are the error terms.

4.Results

4.1 Descriptive statistics and correlation analysis

Table 3 presents the descriptive statistics and correlations between variables. It can be seen that, the mean values of green innovation, normative pressure, coercive pressure are 0.650 (which is log value), 0.275 (which ranges from 0 to 2) and 7.157 (which ranges from 0 to 10), respectively, revealing low level of green innovation, weak normative pressure and strong coercive pressure. Besides, the maximum and minimum values, mean and standard deviation of organizational slack, ownership,

leadership structure, industry type, firm size, board independence and growth illustrate the characteristics of the sample observations.

Table 3 here

Table 4 provides the statistics of media judgements of companies from 2008 to 2014. There are 26,053 and 15,701 positive and neutral reports of sampled companies, but only 2,596 negative ones, which indicates the media's propensity to tell good news about firms.

Table 4 here

4.2 Hypothesis testing

As longitudinal unbalanced panel data, generalized estimating equations (GEE) approach was used to test the above hypotheses, which derive maximum likelihood estimates and accommodate non-independent observations (Liang and Zeger, 1986).

4.2.1 Main Effects

Model 1 reflects the relationships among control variables and the dependent variable. Model 2 introduces the independent variables and suggests that both normative pressure (β=0.274, $p<0.05$) and coercive pressure (β=0.089, $p<0.01$) are significantly positively correlated with green innovation, which means that the greater the normative and coercive pressure, the more inclined the firm will engage in green innovation. Therefore, both H1a and H1b are supported.

4.2.2 Moderating Effects

Model 3 is logistic regression analyses of moderating variables on dependent variables and shows that organizational slack has no significant relationship with green innovation. Model 4 was generated based on Model 3 by introducing the interactive item of coercive pressure, normative pressure and organizational slack. The results show that organizational slack positively moderates the relationship between coercive pressure and green innovation (β=0.078, $p<0.01$), but has no significant impact on the relationship between normative pressure and green innovation (β=0.124, $p>0.1$). So H2a is supported, while H2b is not.

Table 5 here

4.3 Robustness test

To test the robustness of the results, alternative measurements of dependent, independent and moderating variables are used. Specifically: (1) replacing green invention patents for all three kinds of green patents (patent for invention, patent of utility model and patent of appearance) to measure green innovation; (2) using total investment in environmental pollution control instead of the Marketization Index for the measure of coercive pressure; and (3) adopting firms' cash holding scaled by firms' market capitalization at year t −1 as an alternative measure of organizational slack. As reported in Table 6, the results held qualitatively unchanged（Model 5-8）.

Table 6 here

5. Discussions

First, both coercive and normative pressures have positive and significant effects on a firm's green innovation, providing support for the Porter Hypothesis. That is, coercive and normative pressures will facilitate rather than inhibit corporate green innovation. This finding is at odds with the conventional economic view that institutional pressure cannot drive the environmental protection behaviors of firms (Zhang et al., 2015), and that it is internal factors such as profit, corporate image, the environmental orientation of firms or managers, and green market expectations that drive green innovation (Dangelico and Pujari, 2010). Nonetheless, this finding is consistent with the revisionist view that the pressure and impetus brought by environmental policies will encourage firms to make green innovations to meet the requirements of regulations (Hamamoto, 2006; Beerepoot et al., 2007); that legitimacy pressures will promote corporate green innovation (Li et al., 2016; Huang et al., 2016); that institutional pressures will drive firms to implement sustainable supply chain management and thus promote green production (Zeng et al., 2016). Thus, this study, situated in an emerging economy of China with an in-depth decomposition of institutional pressure, helps clarify the debate on the Porter Hypothesis.

Second, the positive moderating effect of organizational slack between coercive pressure and green innovation supports the resource-based view rather than agency theory, that slack is an important buffer and catalyst for green innovation when facing stringent environmental regulations. However, we also evidence a different

moderating effect according to the types of institutional pressures. While coercive pressures have a significant positive impact on green innovation in firms with more organizational slack, the impact of normative pressures on green innovation is not significantly affected by organizational slack. One possible reason for these results is that compared with normative pressure, coercive pressure is compulsory and can be immediately costly (through such means as penalties, ordering firms to suspend operations, setting market access thresholds, emissions trading, etc.). Its impact on corporate operations is more salient, so firms are more sensitive to coercive pressure. So high slack enhances coercive pressure on corporate green innovation as it provides the necessary resources and managerial discretion to explore new opportunities and solutions exerted by coercive pressure, such as investing in experimentation or spending on environmentally-friendly projects (Arena et al., 2018). However, normative pressure may not be so impulsive and direct. Due to information asymmetry and agency problems, self-interest oriented managers may use organizational slacks to meet the environmental requirements of the public through participating in symbolic environmental claims rather than substantive green innovations when facing normative legitimacy pressures.

6. Conclusions and implications

6.1 Conclusions

This study explores the question of why some firms engage in more green innovations than others by analyzing the impact of institutional pressure (coercive and

normative pressure) on green innovation and investigating the moderating role of organizational slack. With a sample of 370 observations of the top 100 listed companies in China from 2008 to 2014, we found that both coercive pressure and normative pressure have significant positive effects on corporate green innovation. In addition, organizational slack positively moderates the relationship between coercive pressure and green innovation, but the moderating effect on the relationship between normative pressure and green innovation is not significant.

6.2 Practical implications

These findings have several practical implications. First, coercive pressures can foster rather than hinder corporate green innovation, demonstrating that the government should strengthen the implementation of coercive tools such as laws and regulations of environmental protection, accelerate market-oriented environmental regulation approaches like emissions trading and emission reduction subsidies.

Second, normative pressures also can have a positive impact on green innovation, indicating that we should constantly improve the participation of the public, consumers, community residents and other stakeholders on environmental supervision and allow media supervision to play a larger role. In terms of environmental supervision, the media should have the courage to play roles of "muckraking", "catalyst" and the "vanguard" of public inquiry. With the increase in public concern about environmental issues, green innovation will become a more promising policy for managers to follow.

Third, we suggest that coercive pressure is particularly beneficial for green

innovation when the firm has excess resources that allow more risk-taking and enable long-term orientation. This indicate that firms should take full advantage of slack resources such as additional materials, cash and talents to make innovations, and combine them with environmental practices when facing institutional pressures.

6.3 Limitations and future research opportunities

There are some limitations for future research in this study. First, corporate green innovation is driven by various formal and informal, external and internal factors including intellectual capital, environmental performance, industrial competition and so on. However, this study was confined to the impact of external normative pressure, coercive pressure and internal organizational slack. Second, the findings were based on China 's top 100 listed companies, which may apply only to large enterprises in emerging economies, but not to small and medium-sized firms and developed countries. Future studies should cover and compare firms from different scales and different countries.

Compliance with Ethical Standards

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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Table1 Sample distribution by year and industry

Industry type	Year							Subtotal	%
	2008	2009	2010	2011	2012	2013	2014		
Coal Mining and Dressing	3	4	6	4	7	6	1	31	8.38
Oil and gas extraction	2	4	3	3	5	4	4	25	6.76
non-ferrous metals mining and dressing	1	2	4	4	5	4	1	21	5.68
Wine, beverages and refined tea manufacturing	2	4	3	4	5	4	3	25	6.76
Chemical (industry and fine) and pharmacy	0	2	2	6	4	5	8	27	7.30
Non-metallic mineral products	3	2	1	1	1	1	1	10	2.70
Metal smelting and rolling processing	6	6	7	5	5	4	1	34	9.19
General and special equipment manufacturing	5	4	4	5	3	2	3	26	7.03
Auto manufacture and auto components	3	1	4	5	4	3	5	25	6.76
Electrical machinery and equipment manufacturing	0	3	3	3	2	2	4	17	4.59
Telecommunication and IT	2	2	2	2	3	3	8	22	5.95
Power, thermal production and supply	4	4	3	3	4	3	2	23	6.22
Transport and transport infrastructure	10	9	3	4	8	4	2	40	10.81
Public facilities management	0	2	2	2	1	1	1	9	2.43
Trade and retail	0	2	2	3	1	2	2	12	3.24
Others	7	3	2	2	3	3	3	23	6.22
Total by year	48	54	51	56	61	51	49	370	100

Other industries include textile, paper and forestry products, construction and material, and agricultural food processing.

Table 2 Measurements of control variables used in this research

Variables	Symbols	Measuring methods
Ownership	Own	Dummy variable, 1 for state-owned enterprises (SOEs), 0 for others.
Leadership Structure	LS	Dummy variable, 1 refers to a company whose chief executive officer (CEO) is not the chairperson of the board (COB), 0 otherwise.
Industry Type	Ind	Dummy variable, 1 for heavily polluting industries, 0 otherwise.
Board Independence	Indep	The independent directors/board size ratio
Firm Size	Size	The logarithm of total assets
Growth	Gro	The ratio of (current POR- previous POR)/previous POR ("POR" refers to prime operating revenue).

Table 3 Descriptive statistics and correlation matrix

	1	2	3	4	5	6	7	8	9	10
1.GI										
2.NP	0.154***									
3.CP	0.295***	-0.069								
4.OS	0.365***	0.106**	0.149***							
5.Own	-0.108**	-0.044	0.099*	0.219**						
6.LS	-0.121**	-0.050	0.045	0.043	0.064					
7.Ind	0.161***	0.125**	-0.144***	0.096*	0.066	-0.071				
8.Size	0.514***	0.000	0.287***	0.756***	0.206***	0.092*	-0.003			
9.Indep	-0.008	-0.054	0.052	0.065	0.073	-0.027	0.021	0.107**		
10.Gro	-0.034	-0.071	0.065	-0.078	0.039	0.061	-0.100*	-0.031	0.144***	
Min	0.000	0.000	2.530	14.763	0.000	0.000	0.000	9.110	0.125	-2.683
Max	2.85	1.763	9.950	22.458	1.000	1.000	1.000	12.381	0.714	6.245
Mean	0.650	0.275	7.157	17.939	0.857	0.881	0.784	10.708	0.381	0.135
SD	0.741	0.319	1.670	1.011	0.351	0.324	0.412	0.559	0.0070	0.546

Notes: ***p<0.01,**p<0.05, *p<0.1.Two-tailed. N=370

Table 4 Media judgments of China Top 100 from 2008 to 2014

Judgments	Year							Total	Percentage
	2008	2009	2010	2011	2012	2013	2014		
Positive	3997	4332	3618	2988	3151	4064	3903	26053	0.5874
Neutral	1231	1763	2117	2486	2619	2730	2755	15701	0.3540
Negative	354	297	408	355	376	416	390	2596	0.0585
Total	5582	6392	6143	5829	6146	7210	7048	44350	1

Table 5 Generalized Estimating Equations Results

Generalized Estimating Equations				
Dependent Variables	Green Innovation			
	Model 1	Model 2	Model 3	Model 4
1.Control Variables				
Ownership	0.512**	0 .510* *	0.510**	0.493**
Leadership Structure	0.397***	0.386***	0.423***	0.439***
Industry Type	-0.328*	-0.348**	-0.377**	-0.358**
Firm Size	0.780***	0.703***	0.805***	0.720***
Board Independence	-0.792	-0.739	-0.757	-0.698
Growth	0.050	0.040	0.028	0.030
2.Independent Variable & Moderating Variable				
Normative Pressure		0.274**	0.254**	0.248**
Coercive Pressure		0.089***	0.087***	0.104***
Organizational Slack			-0.072	-0.065
3. Moderating Effect				

CP*OS	0.078***
NP*OS	0.124

Notes: *** p<0.01,** p<0.05,* p<0.1 N=370.

Table 6 Robustness Test Results

Generalized Estimating Equations				
Dependent Variables	Green Innovation			
	Model 5	Model 6	Model 7	Model 8
1.Control Variables				
Ownership	0 .540**	0.500* *	0.480**	0.488**
Leadership Structure	0.431***	0.415***	0.391**	0.394**
Industry	-0.402**	-0.381**	-0.345*	-0.364*
Firm Size	0.852***	0.829***	0.893***	0.906***
Board Independence	-0.729	-0.551	-0.613	-0.569
Growth	0.028	0.030	0.016	0.007
2.Independent Variable & Moderating Variable				
Normative Pressure		0.258**	0.254**	0.264**
Coercive Pressure		0.163***	0.165***	0.138**
Organizational Slack			0.114	-0.996
3. Moderating Effect				
CP*OS				0.158*
NP*OS				-0.059

Notes: *** p<0.01,** p<0.05,* p<0.1 N=370