Journal of Cleaner Production 260 (2020) 121028

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Corporate social responsibility and collaborative innovation: The role of government support

Huanyong Ji , Zhongzhen Miao *

School of Public Policy and Management, Tsinghua University, Beijing, 100084, China

ARTICLE INFO

Article history:
Received 26 November 2019
Received in revised form
19 February 2020
Accepted 9 March 2020
Available online 10 March 2020

Handling editor: Zhifu Mi

Keywords:
Corporate social responsibility
Collaborative innovation
Direct government support
Indirect government support
China

ABSTRACT

Recent literature argues that corporate social responsibility (CSR), especially the social-oriented type, may enhance collaborative innovation. However, these studies overlook other CSR dimensions that may also benefit collaborative innovation; in addition, they mainly study these activities in developed economies, few has considered those in developing countries, where CSR might affect collaborative innovation through a different mechanism. Therefore, this paper aims at exploring the impacts of different CSR dimensions (i.e., environmental CSR, social CSR, and corporate governance) on collaborative innovation. It also reveals the mechanism through which CSR affects collaborative innovation in developing countries by exploring the moderating effects of government support (i.e., direct and indirect government support) on these relationships. Based on a panel data analysis covering the period 2008 to 2016 in China, our findings indicate that social CSR may not enhance collaborative innovation in developing countries, which contrasts findings from developed countries; moreover, both direct and indirect government support could enhance the positive effect of environmental CSR on collaborative innovation, while the indirect one could also promote the positive effect of corporate governance on collaborative innovation. The findings provide theoretical and practical implications for the understanding of whether firms can improve collaborative innovation through socially responsible manners.

1. Introduction

Firms have received greater attentions on their corporate social responsibility (CSR) with the growing public concerns on environmental and social issues in recent years (Ludbrook et al., 2019). Accordingly, how CSR could facilitate sustainable development of firms has become one of critical subjects in the CSR field (Burke and Logsdon, 1996).

Existing research maintains that innovation is the key pathway through which CSR achieves sustainable development of firms (Sharma and Vredenburg, 1998). Specifically, recent literature argues that CSR are more likely to promote collaborative innovation (Dingler and Enkel, 2016). However, these studies primarily consider the social dimension of CSR, ignoring other CSR dimensions that may also create collaborative opportunities (Graessley et al., 2019). In fact, CSR involve not only the social aspect but also other dimensions such as environmental CSR and corporate governance, which are called ESG (environmental, social, and corporate governance CSR) (Friede et al., 2015) – the variety of CSR activities may lead to different impacts on collaborative innovation. Prior literature has tentatively studied the impacts of different CSR on innovation, such as environmental CSR (Sharma and Vredenburg, 1998) and corporate governance (Honore et al., 2015) respectively. However, these studies have yet to extend to the understanding of different impacts of heterogeneous CSR on collaborative innovation.

Moreover, current literature mainly discusses the impact of CSR on collaborative innovation in developed countries, few has extended such relationship in developing countries. Recent studies suggest that the mechanisms through which CSR influences collaborative innovation in developing countries might be different from those in developed ones (Ji et al., 2019): in developed countries, CSR is normally adopted by firms for meeting market demands (Ho, 2017); on the contrary, CSR in developing countries has

Abbreviations: CSR, corporate social responsibility; SIC, standard industrial classification; R&D, research and development; ROA, return on assets; Ln, natural logarithm; Dummies, Dummy variables; ai, indicates the firm-specific fixed-effect; zt, indicates the time fixed-effect; B, indicate the coefficients; εit, indicates standard residual.

* Corresponding author.
E-mail address: zhongzhenmiao@mail.tsinghua.edu.cn (Z. Miao).

https://doi.org/10.1016/j.jclepro.2020.121028
0959-6526/

become an important response to government pressures on social and environmental issues to gain government support (Ji et al., 2019). Government support refers to "the extent to which a particular firm gains assistance such as favorable policies, incentives, and programs from the government and its administrative bureaus" (Shu et al., 2016, p 472), Although recent studies suggest that government support could pay a key role in the relationship between CSR and innovation (Shu et al., 2016), few has considered the heterogeneity of government support (Nishimura and Okamuro, 2011), which may create disparate impacts on the relationship between CSR and innovation (henceforth, the CSR-Innovation relationship). Therefore, it is necessary to further explore the role of the heterogeneity of government support in the relationship between CSR and collaborative innovation when we extend the research on the relationship between CSR and collaborative innovation in the context of developing countries.

This paper, therefore, addresses above research gaps and aims at investigating following questions:

(1) Do different dimensions of CSR influence collaborative innovation?
(2) How do different types of government support affect the relationship between CSR and collaborative innovation?

To resolve above research questions, firstly, this paper explores the impacts of different dimensions of CSR (environmental CSR, social CSR, and corporate governance) on collaborative innovation. In this paper, *Environmental CSR* refers to a firm's efforts on making a positive impact on the environment proactively (Hart, 1995); *social CSR* refers to a firms' efforts on social issues that not only include firms' internal issues such as health and safety initiatives, but also concern external issues, such as philanthropic activities (Wang and Sarkis, 2017); *corporate governance* incorporates firm ethics and integrity, including principles such as accountability, compliance, and transparency (Keasy and Wright, 1997).

Secondly, drawing on previous studies (Nishimura and Okamuro, 2011), this study conceptualizes government support into direct and indirect government support, and examines their distinct impacts on relationship between CSR and collaborative innovation. Direct *government* support means that government assists a firm directly, such as providing subsidies (Mardoyan and Braun, 2015) or tax reductions (Enzensberger et al., 2002). *Indirect government* support means that government assists a firm indirectly, either in form of building inter-organizational network (Nishimura and Okamuro, 2011), providing financial guarantees (Harborne and Hendry, 2009) and publicity (Sarkar and Singh, 2010). Both direct and indirect government support are legislative instruments implemented by government bodies because resources used by government to support firms must be authorized legally (Chen and Naughton, 2016)[1]. Comparing with direct government support, the implementation of indirect government support normally relies on the involvement of various actors (e.g., financial institutions, universities, suppliers, and public research institutions) to ensure a strategic target.

China provides an ideal setting to test our framework. This is because China is the largest developing country in the world that has many characteristics in common with other developing countries. It could benefit our findings to be applicable in other countries. Many previous studies regarding CSR in developing countries have chosen China as the reprehensive case (Luo et al., 2017). Moreover, China has been undergoing "a green revolution" in various industries for the purpose of sustainability (Zhou et al., 2018). Many policies have been issued by government bodies to support the sustainable development of firms (Chen et al., 2017).

The remainder of this paper is organized as follows. Section 2 includes a review of the relevant literature and the research hypotheses. Section 3 presents the methods, including sample, dataset and variables. Section 4 presents the study results and the robustness tests under various empirical assumptions. Section 5 concludes this paper with a discussion of implications to CSR and innovation field.

2. Theory and hypotheses

2.1. Review on CSR-Innovation research

Traditionally, research on the CSR-Innovation relationship is grounded primarily in developed countries and recognizes CSR as channels to acquire information, knowledge, and financial resources from external environments that can be used for internal investments on different stages of innovation (Surroca et al., 2010), including idea generation (Udell et al., 2019), problem-solving (Li et al., 2015, 2019), and implementation (Hollowell et al., 2019; Maroušek et al., 2019a, 2019b). For instance, Luo and Du (2015) indicate that CSR could stimulate knowledge inflows from various stakeholders that can benefit idea generation; Sharma and Vredenburg (1998) find that CSR could enrich problem-solving approaches by establishing trust-based stakeholder relationships; Mishra (2017) finds that CSR could reduce the new product failure by enhancing social reputation.

Early research focuses primarily on the impact of specific environmental CSR on innovation (Sharma and Vredenburg, 1998) – This group of literature argues that environmental CSR can help firms to acquire green-related information and resources that can help firms to invest in green technologies and improve their products accordingly. Meanwhile, there is another stream of literature that discusses about the relationship between corporate governance and innovation (Honore et al., 2015). These studies indicate that an effective corporate governance could minimize the conflicts between firm managers and external shareholders in order to obtain the supports of the latter on innovation investments, hence impacting innovation. On top of this, some literature concerns about a more general concept of CSR (Wagner, 2010) rather than a specific dimension of CSR. However, most of the above-mentioned research views CSR as mechanisms to acquire external resources (e.g., information, knowledge, finance) to better invest in within-firm innovations. (Mcwilliams and Siegel, 2001). In contrast, some recent studies suggest that CSR can be recognized as opportunities that helps firms to establish inter-organizational collaborations for resource exchanges, such as reciprocal knowledge exchanges between firms (Luo and Du, 2015) – but they have yet to talk about collaborative innovation.

Amid the prosperity of collaborative innovation research, some start to study the impacts of CSR, more specifically, on collaborative innovation – they argue that CSR can help to build social reputation that leads to more opportunities for external collaborations especially in innovation (Bereskin et al., 2016). For example, by investigating eight collaboration-cases in the UK, Holmes and Smart (2009) find that firms' efforts on social issues can help them to conduct collaborative innovation together with non-profit organizations that are usually not economic-driven. In addition, Dingler and Enkel (2016) examine the German mechanical engineering industry, and also note that firms' social activities can facilitate

[1] For instance, in U.S., the government budget that includes funds to support firms must be approved by the Congress. Similar in China, resources used by government to support industries must be authorized by the National People's Congress. Both the U.S. congress and the National People's Congress are institutions that have legislative authority.

inter-organizational knowledge transfer especially in cross-industrial collaborations. However, these studies primarily focus on social dimension of CSR. In fact, other CSR dimensions, such as environmental CSR and corporate governance, may also help to build market reputation and hence benefit collaborations (Luo and Du, 2015). Therefore, the heterogeneity of CSR and their impacts on collaborative innovation needs further empirical investigation.

Current research on the CSR-Innovation relationship is mainly discussed within the background of developed countries. Much less research has examined this in developing economies; in addition, although these limited attempts mainly explore the impacts of general CSR (Ji et al., 2019), environmental CSR (Yang et al., 2018) and corporate governance (Yi et al., 2012) on innovation – few has extended this to more specifically on collaborative innovation. Moreover, these studies suggest that the CSR-Innovation relationship could be leveraged by government support (Shu et al., 2016). These contributions mainly view government support as a composite indicator. However, previous literature indicates that there are different types of government support, i.e., direct and indirect government support, which may impact firms' operations and performance in different ways (Nishimura and Okamuro, 2011). Therefore, it is necessary to further investigate the heterogenous impacts of the different types of government support in the relation between CSR and collaborative innovation.

2.2. CSR and collaborative innovation

2.2.1. Environmental CSR and collaborative innovation

Existing research argues that firms' environmental CSR encourages innovation through a variety of mechanisms. For example, Sharma and Vredenburg (1998) indicate that environmental CSR can help firms to acquire external green-related information and knowledge so that they may strategically increase their investments on green technologies. In addition, Nidumolu et al. (2009) also suggest that environmental CSR can help firms to strategically allocate more resources on green innovation. However, these contributions only concern about environmental CSR's impacts on within-firm innovations. By contrast, some recent attempts state that firms' environment CSR may also help firms to establish external connections for reciprocal resource exchanges between organizations, through building social reputation in market. For instance, Shu et al. (2016) and Ji et al. (2019) indicate that due to growing public concerns on environmental issues, environmental CSR could help firms to acquire external supports from other entities, e.g. the government and universities, which may lead to collaborations. Therefore, we propose the following hypothesis:

H1a. Environmental CSR positively affects collaborative innovation.

2.2.2. Social CSR and collaborative innovation

Social CSR could enhance firms' social reputation by coping with social issues that are concerned by customers, employees and the communities (Brammer and Millington, 2005). Such social reputation could make firms to be viewed by peer organizations as "good citizens" and reliable business partners that are not short-term opportunistic (Flammer, 2018). For instance, social CSR, such as supporting local communities, donating to charities and providing training and career development opportunities, would help firms build social images of committing to the long run rather acting opportunistically in the short run (Flammer and Bansal, 2017). Therefore, social CSR could help firms to gain more opportunities for tangible collaborations especially in innovation, which are risky and required long-term mutual trust between partners (Dingler and Enkel, 2016). Therefore, we propose the following hypothesis:

H1b. Social CSR positively affects collaborative innovation.

2.2.3. Corporate governance and collaborative innovation

Existing literature maintains that there are always conflicts between shareholders and firm managers. The former ones are usually interested in long-term strategies and therefore are more risk-tolerate in short-term commitments; on the contrary, firm managers are more committed to short-term goals so that they are very much risk-adverse especially on highly-uncertain activities such as innovation (Honore et al., 2015). Therefore, some recent research argues that an effective corporate governance could align the interests of shareholders and managers, hence promoting firms' investments on product/manufacturing innovations (Driver and Guedes, 2012). However, none of these studies have extended the impacts specifically on collaborative innovation. Collaborative innovation may appeal to both firm managers and stakeholder – it can solve the short-term issues of firm managers when reducing innovation cycles and shorten the time to market (Enkel et al., 2009), and can also cope with the long-term concerns of stakeholders when sharing strategic risk with other collaborators (Yang and Chen, 2017). Therefore, we argue that better corporate governance that align managers' decisions to shareholders' interests might lead to positive impact on collaborative innovation. Accordingly, we propose the following hypothesis:

H1c. Corporate governance positively affects collaborative innovation.

2.3. The moderating role of government support

Government support provides firms with access to many critical resources, such as tax rebates, subsidies and financial grantees (Enzensberger et al., 2002). These resources may be especially important in developing countries where the imperfective market mechanism makes firms have higher inclination to build rapport with governments to gain critical resources (Marquis and Qian, 2014). According to institutional theory, firms can obtain government support by meeting the demands and expectations of government bodies (Ji et al., 2019). With the growing government concerns on environmental and social issues in developing countries such as China, CSR has become an effective way to gain government support to secure the legitimacy and obtain favorable treatment (Shu et al., 2016). Drawing on previous studies (Zhou et al., 2015), there are two kinds of government support, namely, direct and indirect government support. Based on previous studies. such distinct government support may bring disparate influences on firms' operations and performance (Nishimura and Okamuro, 2011).

This paper predicts that direct government support could positively moderates the relationships between different dimensions of CSR and collaborative innovation. Direct government support could provide necessary resources for firms. A firm received direct government support can provide complementary resources for its peer organizations due to the fact that firms in developing countries are normally short of necessary resources (Shu et al., 2016). Therefore, direct government support can enhance a firm's opportunities of developing new collaborations (David et al., 2000). For instance, Ren et al. (2019) find that government subsidies could encourage firms to search for new solutions on environmental and social issues across organizational boundaries. Luo et al. (2017) indicate that training programs on

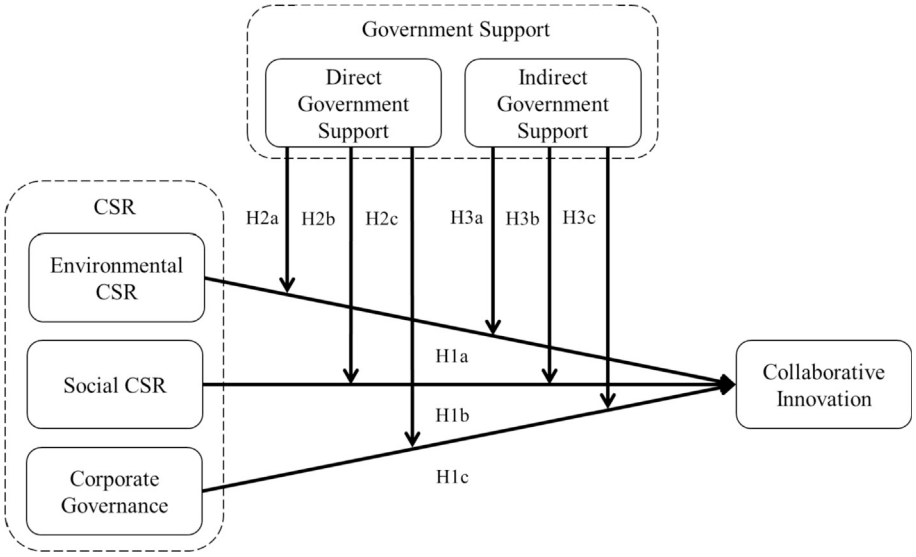

Fig. 1. Conceptual framework.

corporate governance provided by governments could enhance promote a firm's governance capability, thus enhancing its impacts on firm performance. Therefore, we propose the following hypotheses:

H2a. *direct government support strengthens the relationship between environmental CSR and collaborative innovation.*

H2b. direct government support strengthens the relationship between social CSR and collaborative innovation.

H2c. *direct government support strengthens the relationship between corporate governance and collaborative innovation.*

This paper also predicts that indirect government support could positively moderates the relationships between different dimensions of CSR and collaborative innovation. Comparing with direct government support, indirect government support is more market-oriented (Lee et al., 2011) and can mobilize more economic actors, thus enhancing the market function in allocating resources (Nishimura and Okamuro, 2011). Prior studies indicate that CSR could bring collaborative opportunities because it can enhance the social image and transparency of communications between the focal firm and its stakeholders (Dingler and Enkel, 2016), thus reducing information asymmetry between organizations (Milward et al., 2019; Deggans et al., 2019; Stehel et al., 2019). However, recent studies indicate that although the value of CSR have been fully embraced by government bodies in developing countries, they are still not well recognized by firms (Moon and Shen, 2010). Therefore, indirect government support would enhance the effect of CSR on collaborative innovation by involving more economic actors in CSR programs. It can also help CSR create more collaborative opportunities by enhancing the public awareness of CSR in forms of propagandizing the value of environmental and social initiatives as well as corporate governance. Therefore, we propose the following hypotheses:

H3a. *indirect government support strengthens the relationship between environmental CSR and collaborative innovation.*

H3b. *indirect government support strengthens the relationship between social CSR and collaborative innovation.*

H3c. *indirect government support strengthens the relationship between corporate governance and collaborative innovation.*

The conceptual framework is presented in Fig. 1.

3. Methods

3.1. Sample

The sample is carefully assembled from multiple data sources through 4 steps:

(1) The initial dataset is drawn from the *Osiris*, which has the information about public listed firms around the world (Zhang et al., 2018). Firms are selected based on Standard Industrial Classification (SIC) codes, while SIC codes 31, 32, 33 for Manufacturing as well as sub-level codes. The initial sample includes 2416 firms.[2]
(2) 692 firms are remained after we match the initial sample with *Bloomberg ESG database*, which adopts the most comprehensive methodology to evaluate firms' environmental CSR, social CSR and corporate governance, and has been widely used for evaluating CSR performance in prior studies (Benlemlih et al., 2018).
(3) In line with Zhang et al. (2018), considering that the observation period is 9 years in our sample, firms with less than 4 years' CSR data are excluded. We then gain final sample of 380 firms.
(4) We match the final sample with other database, including the *Marketization of China's Provinces: NERI Report 2018*,[3] *Derwent World Patents Index*[4] and *National Bureau of Statistics of China*. We also use firms' annual reports to obtain information not available in the *Osiris*. Out of these 380 firms, 45 belong to SIC code 31 (11.81%), 133 belong to SIC code 32

[2] As the largest manufacturer in the world, manufacturing firms (2416) account for more than two thirds of total public listed firms (3543) in China in 2018.
[3] NERI report is developed by the China National Economic Research Institute since 2001, and its marketization index has been widely used in previous studies (Gong et al., 2018).
[4] DWPI database covers patent data from more than 40 patent offices around the world, and provides comprehensive, consistent and accurate patent data through rewriting each patent's information by technical and patent savvy experts. This data source has been widely used in prior studies (Kong et al., 2017).

Table 1
Industry distribution.

Industry	Number of firms	Percentage (%)
Food Manufacturing (311)	14	3.684
Beverage and Tobacco Product Manufacturing (312)	9	2.368
Textile Mills (313)	5	1.316
Textile Product Mills (314)	5	1.316
Apparel Manufacturing (315)	10	2.632
Leather and Allied Product Manufacturing (316)	2	0.526
Paper Manufacturing (322)	9	2.368
Printing and Related Support Activities (323)	3	0.789
Petroleum and Coal Products Manufacturing (324)	3	0.789
Chemical Manufacturing (325)	94	24.737
Plastics and Rubber Products Manufacturing (326)	8	2.105
Nonmetallic Mineral Product Manufacturing (327)	16	4.211
Primary Metal Manufacturing (331)	43	11.316
Fabricated Metal Product Manufacturing (332)	10	2.632
Machinery Manufacturing (333)	49	12.895
Computer and Electronic Product Manufacturing (334)	47	12.368
Electrical Equipment, Appliance, and Component Manufacturing (335)	23	6.053
Transportation Equipment Manufacturing (336)	19	5
Furniture and Related Product Manufacturing (337)	2	0.526
Miscellaneous Manufacturing (339)	9	2.368
Total	**380**	**100**

Note: the numbers in parentheses are SIC codes.

(34.91%), 203 belong to SIC code 33 (53.28%). Details of the industry distribution are shown in Table 1.

The time frame of our sample is from 2008 to 2016. We choose 2008 as the starting year of the panel dataset, because China's stock exchanges officially issued CSR guidelines at the end of 2007 – the CSR reports of the majority of listed firms start to be available after that, i.e. less than 100 CSR reports in 2007, and over 300 in 2008. Our dataset ends in 2016 because the data for measuring the variable of indirect government support only covers the time period from 2008 to 2016.

3.2. Variables

3.2.1. Dependent variable: collaborative innovation

We use collaborative patents (i.e. patents are co-authored or jointly-owned by the focal firm and other organizations) to measure the collaborative innovation between our sample firms and other organizations – this measurement has been validated in some previous studies (Belderbos et al., 2010). Collaborative patents are retrieved from the Derwent World Patents Index (DWPI) database, and this paper uses the basic patent applications for analysis as they are a better indicator of the original innovative activities; in addition, we use the priority year of patent submissions/applications as the patenting year (Zhou et al., 2016). In total, this dataset includes 28,876 collaborative patents. Following existing literature (Mishra, 2017), we measure the collaborative innovation by using the variable of the natural log of the annual number of collaborative patents by patent application year plus one (+1 aims to avoid the number of collaborative patents become 0 that causes invalid log).

Independent variables: environmental CSR, social CSR and corporate governance.

We utilize CSR indicators that have been disclosed in Bloomberg ESG database to measure CSR activities. Bloomberg ESG database evaluates firms' CSR activities through channels like CSR report, news and other medias. It tracks more than 120 metrics, grouped by environmental CSR, social CSR and corporate governance, and weights differently for different industries. Each variable score ranges from 0 for firms that do not disclose any CSR-related data, to 100 for those that disclose CSR data on all available variables within the CSR category (Benlemlih et al., 2018).

3.2.2. Moderating variable: direct and indirect government support

We measure direct government support by using the natural log of provincial GDP. This measurement is in line with prior studies, which indicate that the better provincial economic development, the more resources could be utilized by the provincial government to directly support CSR as well as innovation activities (Marquis and Qian., 2014).

According to previous studies (Gong et al., 2018), we measure indirect government support by using marketization index from the NERI Report (Wang et al., 2019). The marketization index is ranged from 0 to 10. The higher the values of marketization index, the more economic actors from the market could be utilized by the government, thus providing more indirect government support (Ji et al., 2019).

3.2.3. Control variables

Several variables that might impact collaborative innovation are included as control variables in the analyses. First, firm size is considered because current studies suggest that big firms have more resources which can help them to establish their relationships with other organizations (Arundel and Geuna, 2004). We measure firm size by using the natural log of total assets by fiscal year end. Second, research and development (R&D) expense is considered because R&D investments can develop a firm's ability to exploit and absorb knowledge from the environment (Cohen and Levinthal, 1989). We measure R&D expense by using the natural log of R&D expense by fiscal year end plus one (as we did to dependent variable). Third, current ratio is considered because it can reduce risk associated with innovation (Yang and Chen, 2017). Fourth, return on assets (ROA) is included because it could affect innovation performance according to prior studies (Ji et al., 2019). Fifth, year (2008–2016) dummies are included to control for differences in industries and macroeconomic trends across time. Finally, a one-year lagged value of collaborative innovation is controlled to avoid any residual unobserved heterogeneity across firms. The measurement and sources of all variables are shown in Table 2.

Table 2
Measurements.

Variables	Measurements	Sources
Dependent variable		
Collaborative innovation	Ln (collaborative patents+1)	DWPI
Independent variables		
Environmental CSR	Environmental index	Bloomberg ESG database
Social CSR	Social index	
Corporate governance	Corporate governance index	
Moderating variables		
Direct government support	Ln (GDP)	National Bureau of Statistics of China
Indirect government support	Marketization index	Marketization of China's Provinces: NERI Report 2018
Control variables		
Firm size	Ln (total assets)	Osiris
R&D	Ln (R&D expense +1)	
Current ratio	Current assets/current liabilities	
ROA	Return on assets	
Year dummies	Year dummies (2008–2016)	
lagged collaborative innovation	One-year-lagged Ln (collaborative patents+1)	DWPI

Notes: (1) Ln = natural logarithm.[51] (2) Dummies = dummy variables.[62].

3.3. Model

Existing literature primarily uses cross-sectional data collected from surveys to evaluate the impact of CSR on innovation (Bocquet et al., 2017). However, this method is usually accompanied with common method bias that would decrease the accuracy of the estimations of explanatory variables. To avoid this problem, this study builds upon a panel data set composed of data retrieved from multiple sources to evaluate the impact of CSR on collaborative innovation. This method could minimize the common method bias effectively, even though it normally relies on existing data sources and may not provide real-time information to construct variables.

According to prior studies (Mishra, 2017), this paper adopts fixed effects regression models to analyze the impacts of CSR on collaborative innovation as well as the moderating role of government support in these links after Hausman test. This method can control unobserved variables that have impacts on dependent variables. Specifically, we establish the following model to examine the hypotheses.

$$Y_{it} = B_0 + B_1 X_{i,t} + a_i + z_t + \varepsilon_{it} \quad (1)$$

Where Y_{it} refers to dependent variable, $X_{i,t}$ refers to independent, moderating, control variables as well as interaction terms. a_i indicates the firm-specific fixed-effect; z_t indicates the time fixed-effect; B_0 and B_1 indicate the coefficients; ε_{it} indicates standard residual. All variables within the interaction terms have been standardized.

4. Results

According to Table 3, collaborative innovation correlates strongly with its lagged value as we expected. The correlation matrix shows that most of bivariate correlations are lower than 0.3. The low level of correlation will be unlikely to create the biases of the coefficients of explanatory variables (Zhang et al., 2018).

Table 4 reports the impacts of environmental CSR, social CSR and corporate governance on collaborative innovation. Model 1 indicates that the coefficient of environmental CSR is positive and significant. Therefore, H1a is supported. In Model 2, the coefficient of social CSR is negative and not statistically significant. Therefore, H1b is rejected. In Model 3, the coefficient of corporate governance is positive and significant. Therefore, H1c is supported.

Table 5 reports the moderating effects of direct and indirect government supports on links between CSR dimensions (i.e., environmental CSR, social CSR and corporate governance) and collaborative innovation. According to Model 4–6, only the coefficient of the standardized interaction term of "environmental CSR" and "direct government support" is positive and significant. Therefore, H2a is supported, while H2b and H2c is rejected. According to Model 7–9, the coefficients of the standardized interaction term of "environmental CSR" and "indirect government support" as well as the standardized interaction term of "corporate governance" and "indirect government support" are positive and significant. These results indicate that H3a and H3c are supported and H3b is rejected.

This paper conducts robust tests in two ways. First, potential reverse causality may exist because innovation capabilities may also enhance CSR performance (Surroca et al., 2010). Therefore, according to Mishra (2017), we regress collaborative innovation in Year t on environmental CSR and corporate governance in Year t-4 respectively. This is because collaborative innovation in Year t and CSR in Year t-4 would have little likelihood of being jointly determined. The result shows that the coefficients of environmental CSR and corporate governance are still significant. This result suggests that causality bias cannot drive our results. Second, we test the robustness of moderating effects by employing two alternative indicators: (1) we use GDP per capita (GDP/provincial population) as the proxy of direct government support; (2) we use sub-indicator of marketization index – the relationship between the market and government – as the proxy of indirect government support. The indicator of "the relationship between the market and government" is shown by factors such as the capabilities of markets in allocating resources (Wang et al., 2019). The higher value of such indicator, the more power of the market in allocating resources. The main findings of this research are upheld[7].

In conclusion, the empirical findings show that (1) environmental CSR positively affects collaborative innovation; (2) the effect of social CSR on collaborative innovation is not significant; (3) corporate governance positively impacts collaborative innovation; (4) direct government support positively moderates the relationship between environmental CSR and collaborative innovation; (5) indirect government support positively moderates the relationship between environmental CSR and collaborative innovation as well as

[7] The results of robustness tests can be obtained by connecting the jihuanyong@mail.tsinghua.edu.cn

Table 3
Descriptive statistics and correlation matrix.

	Mean	St. Dev	1	2	3	4	5	6	7	8	9	10
1.Collaborative innovation	0.846	1.329										
2.lagged Collaborative innovation	0.811	1.283	0.835									
3.Environmental CSR	10.462	5.123	0.086	0.064								
4.Social CSR	23.89	6.946	0.039	0.037	0.418							
5.Corporate governance	43.577	4.700	0.068	0.056	0.160	0.167						
6.Direct government support	10.195	0.692	0.156	0.158	−0.045	−0.024	0.036					
7.Indirect government support	7.280	1.746	0.167	0.170	−0.035	−0.013	0.046	0.601				
8.Firm size	8.826	1.221	0.333	0.339	0.203	0.108	0.071	−0.071	−0.103			
9.R&D	3.908	1.826	0.390	0.387	0.148	0.138	0.066	0.171	0.190	0.535		
10.Current ratio	2.253	3.822	−0.063	−0.055	−0.084	0.038	−0.085	0.063	0.032	−0.217	−0.062	
11.ROA	5.234	7.327	−0.016	−0.009	−0.043	0.087	−0.054	0.068	0.067	−0.128	0.037	0.132

Table 4
Fixed effects models predicting collaborative innovation (2008−2016).

Explanatory variables	Model 1	Model 2	Model 3
Environmental CSR	0.020** (0.008)	0.020** (0.008)	0.020** (0.008)
Social CSR		−0.002 (0.006)	−0.004 (0.006)
Corporate governance			0.017** (0.008)
Control and moderating variables	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	2198	2198	2198
R^2	12.15	12.16	12.75

Notes: (1) *, **, and *** indicate statistical significance at the levels of 10%, 5% and 1% respectively; (2) The numbers in parentheses are robust standard errors.

Table 5
Fixed effects models predicting moderating effects (2008−2016).

Explanatory variables	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
ECSR	0.015** (0.006)	0.015** (0.006)	0.017** (0.007)	0.017** (0.008)	0.016** (0.008)	0.016** (0.008)
SCSR	0.001 (0.005)	0.001 (0.005)	0.001 (0.005)	0.001 (0.005)	0.001 (0.004)	0.001 (0.005)
CG	0.015** (0.007)	0.015** (0.007)	0.015** (0.007)	0.015** (0.007)	0.015** (0.007)	0.015** (0.007)
ECSR*DGS	0.066* (0.038)	0.066* (0.038)	0.067* (0.037)	0.097* (0.055)	0.098* (0.058)	0.099* (0.058)
SCSR*DGS		0.016 (0.025)	0.015 (0.025)	0.016 (0.025)	0.008 (0.042)	0.006 (0.042)
CG*DGS			0.033 (0.052)	0.035 (0.053)	0.033 (0.056)	0.026 (0.077)
ECSR*IGS				0.095** (0.045)	0.101** (0.048)	0.108** (0.050)
SCSR*IGS					0.011 (0.042)	0.008 (0.042)
CG*IGS						0.039* (0.022)
Control and moderating variables	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2198	2198	2198	2198	2198	2198
R^2	15.56	15.58	15.61	15.81	15.82	15.98

Notes: (1) ECSR = environmental CSR, SCSR = social CSR, CG = corporate governance, DGS = direct government support, IGS = indirect government support; (2) *, **, and *** indicate statistical significance at the levels of 10%, 5% and 1% respectively; (3) The numbers in parentheses are robust standard errors.

the relationship between corporate governance and collaborative innovation.

This paper produces generalizable findings for following reasons: first, we choose China as the representative case. China is the largest developing country and second largest economy in the world, having many characteristics in common with other developing countries. This could benefit our findings to be generalizable in other countries. Second, our sample involves firms from multiple industries (see Table 1). Therefore, the results could be applied into other countries especially developing economies which has similar industries; Third, we have controlled the factors that may impact the dependent variable (see Table 2) to avoid the omitted variable problem, we also use fixed effects models to control unobserved variables. Moreover, the findings of this paper are upheld through the robustness tests. Therefore, our findings are validity and could be applied in other contexts especially developing countries.

5. Discussion and conclusions

5.1. Discussion

This paper empirically examines the relationships between different dimensions of CSR and collaborative innovation, and has explored the moderating effects of direct and indirect government support on these relationships. Following an empirical analysis of 380 manufacturing firms in China that are publicly traded in a period from 2008 to 2016, this paper finds that:

[5] The natural logarithm of a number is its logarithm to the base of the mathematical constant e, where e is an irrational and transcendental number.

[6] In statistics and econometrics, particularly in regression analysis, a dummy variable is one that takes only 0 or 1 to indicate the absence or presence of some categorical effect that may be expected to shift the outcome. In this paper, we introduce 9 year dummy variables and put 8 of them into the model as previous studies did (Gao and Hafsi, 2015).

(1) The effect of social CSR on collaborative innovation in China is not significant (H2b is rejected). This result is different from those in developed countries (Bereskin et al., 2016). It indicates that social CSR could not enhance collaborative innovation globally – it may not have the positive effect on collaborative innovation in developing countries where market mechanism for allocating resources is imperfective.
(2) Environmental CSR promotes collaborative innovation (H1a is supported). This result echoes prior research that indicate environmental CSR has a positive impact on innovation (Yang et al., 2018), and extends the impacts specifically on collaborative innovation.
(3) The corporate governance promotes collaborative innovation in China (H1c is supported). This result is in line with Dong and Gou (2010) that a good corporate governance would lead to the upgrade of firms' innovation capabilities. This study extends their contributions by probing the positive relationship between corporate governance and collaborative innovation.
(4) Direct government support strengthens only the impact of environmental CSR on collaborative innovation (H2a is supported; H2b and H2c are rejected); Indirect government support strengthens the effects of environmental CSR and corporate governance on collaborative innovation (H3a and H3c are supported; H3b is rejected). This result extends the contributions of recent attempts that find that government support promotes the effect of CSR on innovation (Ji et al., 2019) by exploring the disparate impacts of direct and indirect government support.

5.2. Theoretical contributions

Our findings contribute to the literature on CSR in two aspects. First, this paper enriches collaborative innovation literature by building linkages between different dimensions of CSR and collaborative innovation. Previous strategic literature regarding collaborative innovation mainly considers the determinants of collaborative innovation from the market perspective, including impact factors such as complementary assets (Ketchen et al., 2007) and absorptive capacity (Cohen and Levinthal, 1989), few has discussed the determinants from non-market perspective. Although some recent attempts try to fill in this gap by exploring the impact of social CSR, which is a typical non-market strategy, on collaborative innovation (Dingler and Enkel, 2016), they mainly ignore other CSR types that may also bring collaborative opportunities. Therefore, this paper considers the heterogeneity of CSR in terms of ESG aspects that may create different impacts on collaborative innovation. The empirical findings show that environmental CSR and corporate governance can significantly promote collaborative innovation, while the relationship between social CSR and collaborative innovation is not significant. This result is in contrast with prior studies in developed economies, indicating that social CSR may not help firm create more opportunities of collaborations in innovation in developing countries where social CSR may not be well recognized by the market (Duanmu et al., 2018).

Second, this study reveals the disparate effects of direct and indirect government support on the relationship between CSR and collaborative innovation. Prior studies mainly recognize government support as a composite concept when they discuss its impact on the CSR-Innovation relationship (Ji et al., 2019). Few has yet discussed about which kinds of government support could be more or less effective. This paper conceptualizes government support into direct and indirect ones, and finds that comparing with direct government support, the indirect one that can leverage the more involvement of stakeholders could strengthen the impacts of environmental CSR and corporate governance on collaborative innovation more significantly.

5.3. Managerial and policy implications

Our study increases the confidence of firms that have taken or plan to take CSR activities globally especially in developing countries. Prior studies suggest that unlike developed countries, the value of CSR may not be effectively recognized in developing countries and CSR is not able to bring benefits to firms (Duanmu et al., 2018). Our findings show that although social CSR is not able to enhance collaborative innovation, environmental CSR and corporate governance could bring such benefits by taking China as the representative case. Therefore, it is useful for firms in developing countries to strategize (at current stage) what kinds of CSR can be better attended when planning to promote collaborative innovation with socially responsible manners.

Our study also provides important implications for policymakers. Based on our results, indirect government support can bring more contributions on the relationship between CSR and collaborative innovation than the direct one. Therefore, policymakers should put more efforts on providing indirect supporting programs, such as publicity, financial guarantees or building interorganizational network. This finding may also provide insights to other developing or developed countries where governments involve in the market to a large extent.

5.4. Limitations and future research directions

This study has following limitations. First, although our research design has well addressed the research objectives by taking China as the representative case, research on other countries are also welcomed to further test the research findings of this paper, thus enhancing the understanding of this topic in the CSR field. Second, this study primarily considers collaborative patents as the indicator of collaborative innovation. Given that knowledge inflow/outflow processes might also exist in CSR-facilitated collaborations, future studies could examine other types of collaborative innovation, such as technology licensing, to enrich the CSR-Innovation research. Third, this paper only uses the public traded firms as the research unit. Further research should pay more attention on small medium firms, which play an important role in sustainable economic development globally (Chen et al., 2017).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Huanyong Ji: Methodology, Software, Formal analysis, Writing - original draft, Conceptualization. **Zhongzhen Miao:** Data curation, Visualization, Investigation, Writing - review & editing.

Acknowledgements

This research is supported by the National Natural Science Foundation of China (Grant Numbers: 71872019, 71974107, 91646102, L1824040, L1724030), Beijing Natural Science Foundation (Grant Number: 9182013), Beijing Social Science Foundation (Grant Number: 17GLC058), the Fundamental Research Funds for the Central Universities (Grant Number: 2018XKJC04), and the MOE

(Ministry of Education in China) Project of Humanities and Social Sciences (Grant Number: 16JDGC011), the UK-China Industry Academia Partnership Programme (UK-CIAPP\260), as well as the Volvo-supported Green Economy and Sustainable Development Tsinghua University (20153000181).

References

Arundel, A., Geuna, A., 2004. Proximity and the use of public science by innovative European firms. Econ. Innovat. N. Technol. 13 (6), 559–580.

Belderbos, R., Faems, D., Leten, B., Van Looy, B., 2010. Technological activities and their impact on the financial performance of the firm: exploitation and exploration within and between firms. J. Prod. Innovat. Manag. 27 (6), 869–882.

Benlemlih, Mohammed, Shaukat, Amama, Qiu, Yan, Trojanowski, Grzegorz, 2018. Environmental and Social Disclosures and Firm Risk. Journal of Business Ethics 152 (3), 613–626.

Bereskin, F.L., Campbell, T.L., Hsu, P., 2016. Corporate philanthropy, research networks, and collaborative innovation. Financ. Manag. 45 (1), 175–206.

Bocquet, R., Bas, C.L., Mothe, C., Poussing, N., 2017. CSR, innovation, and firm performance in sluggish growth contexts: a firm-level empirical analysis. J. Bus. Ethics 146 (1), 241–254.

Brammer, S., Millington, A., 2005. Corporate reputation and philanthropy: an empirical analysis. J. Bus. Ethics 61 (1), 29–44.

Burke, L., Logsdon, J.M., 1996. How corporate social responsibility pays off. Long. Range Plan. 29 (4), 495–502.

Chen, L., Zhou, Y., Zhou, D.K., Xue, L., 2017. Clustering enterprises into eco-industrial parks: can interfirm alliances help small and medium-sized enterprises? J. Clean. Prod. 168, 1070–1079.

Chen, L., Naughton, B., 2016. An institutionalized policy-making mechanism: China's return to techno-industrial policy. Res. Pol. 45 (10), 2138–2152.

Cohen, W., Levinthal, D., 1989. Innovation and learning: the two faces of R&D. Econ. J. 99, 569–596.

David, P., Hall, B.H., Toole, A.A., 2000. Is public R and D complement or substitute for private R and D? A review of the econometric evidence. Res. Pol. (29), 497–529.

Deggans, J., Krulicky, T., Kovacova, M., Valaskova, K., Poliak, M., 2019. Cognitively enhanced products, output growth, and labor market changes: will artificial intelligence replace workers by automating their jobs? Econ. Manag. Financ. Mark. 14 (1), 38–43.

Dingler, A., Enkel, E., 2016. Socialization and innovation: insights from collaboration across industry boundaries. Technol. Forecast. Soc. Change 50–60.

Dong, J., Gou, Y., 2010. Corporate governance structure, managerial discretion, and the R&D investment in China. Int. Rev. Econ. Finance 19 (2), 180–188.

Driver, C., Guedes, M.J., 2012. Research and development, cash flow, agency and governance: UK large companies. Res. Pol. 41 (9), 1565–1577.

Duanmu, J., Bu, M., Pittman, R., 2018. Does market competition dampen environmental performance? Evidence from China. Strat. Manag. J. 39 (11), 3006–3030.

Enkel, E., Gassmann, O., Chesbrough, H., 2009. Open R&D and open innovation: exploring the phenomenon. R D Manag. 39 (4), 311–316.

Enzensberger, N., Wietschel, M., Rentz, O., 2002. Policy instruments fostering wind energy projects—a multi-perspective evaluation approach. Energy Pol. 30 (9), 793–801.

Flammer, C., 2018. Competing for government procurement contracts: the role of corporate social responsibility. Strat. Manag. J. 39 (5), 1299–1324.

Flammer, C., Bansal, P., 2017. Does a long-term orientation create value? Evidence from a regression discontinuity. Strat. Manag. J. 38, 1827–1847.

Friede, G., Busch, T., Bassen, A., 2015. ESG and financial performance: aggregated evidence from more than 2000 empirical studies. J. Sustain. Fin. Invest. 5 (4), 210–233.

Gao, Y., Hafsi, T.E., 2015. Government intervention, peers' giving and corporate philanthropy: evidence from Chinese private SMEs. J. Bus. Ethics 132 (2), 433–447.

Gong, G., Xu, S., Gong, X., 2018. On the value of corporate social responsibility disclosure: an empirical investigation of corporate bond issues in China. J. Bus. Ethics 150 (1), 1–32.

Graessley, S., Horak, J., Kovacova, M., Valaskova, K., Poliak, M., 2019. Consumer attitudes and behaviors in the technology-driven sharing economy: motivations for participating in collaborative consumption. J. Self Govern. Manag. Econ. 7 (1), 25–30.

Harborne, P., Hendry, C., 2009. Pathways to commercial wind power in the US, Europe and Japan: the role of demonstration projects and field trials in the innovation process. Energy Pol. 37 (9), 3580–3595.

Hart, S.L., 1995. A natural-resource-based view of the firm. Acad. Manag. Rev. 20 (4), 986–1014.

Ho, V.H., 2017. Corporate social responsibility in China: law & the business case for strategic CSR. South Carolina J. Int. Law Bus. 12 (1), 1–39.

Hollowell, J.C., Rowland, Z., Kliestik, T., Kliestikova, J., Dengov, V.V., 2019. Customer loyalty in the sharing economy platforms: how digital personal reputation and feedback systems facilitate interaction and trust between strangers. J. Self Govern. Manag. Econ. 7 (1), 13–18.

Holmes, S., Smart, P., 2009. Exploring open innovation practice in firm-nonprofit engagements: a corporate social responsibility perspective. R D Manag. 39 (4), 394–409.

Honore, F., Munari, F., La Potterie, B.V., 2015. Corporate governance practices and companies' R&D intensity: evidence from European countries. Res. Pol. 44 (2), 533–543.

Ji, H., Xu, G., Zhou, Y., Miao, Z., 2019. The impact of corporate social responsibility on firms' innovation in China: the role of institutional support. Sustainability 11 (22), 6939.

Keasy, K., Wright, M., 1997. Corporate Governance – Responsibilities, Risks and Remuneration. John Wiley & Sons, New York.

Kong, D., Zhou, Y., Liu, Y., Xue, L., 2017. Using the data mining method to assess the innovation gap: a case of industrial robotics in a catching-up country. Technol. Forecast. Soc. Change 119, 80–97.

Ketchen Jr., D.J., Ireland, R.D., Snow, C.C., 2007. Strategic entrepreneurship, collaborative innovation, and wealth creation. Strategic Entrepren. J. 1 (3-4), 371–385.

Lee, J., Veloso, F., Hounshell, D.A., 2011. Linking induced technological change, and environmental regulation: evidence from patenting in the U.S. auto industry. Res. Pol. 40 (9), 1240–1252.

Li, X., Xie, Q., Jiang, J., Zhou, Y., Huang, L., 2019. Identifying and monitoring the development trends of emerging technologies using patent analysis and Twitter data mining: the case of perovskite solar cell technology. Technol. Forecast. Soc. Change 146, 687–705.

Li, X., Zhou, Y., Xue, L., Huang, L., 2015. Integrating bibliometrics and roadmapping methods: a case of dye-sensitized solar cell technology-based industry in China. Technol. Forecast. Soc. Change 97, 205–222.

Ludbrook, F., Michalikova, K.F., Musova, Z., Suler, P., 2019. Business models for sustainable innovation in industry 4.0: smart manufacturing processes, digitalization of production systems, and data-driven decision making. J. Self Govern. Manag. Econ. 7 (3), 21–26.

Luo, X.R., Wang, D., Zhang, J., 2017. Whose call to answer: institutional complexity and firms' CSR reporting. Acad. Manag. J. 60 (1), 321–344.

Luo, X., Du, S., 2015. Exploring the relationship between corporate social responsibility and firm innovation. Market. Lett. 26 (4), 703–714.

Mardoyan, A., Braun, P., 2015. Analysis of Czech subsidies for solid biofuels. Int. J. Green Energy 12 (4), 405–408.

Maroušek, J., Stehel, V., Vochozka, M., Kolář, L., Marouš ková, A., Strunecký, O., Peterka, J., Kopectý, M., Shreedhar, S., 2019a. Ferrous sludge from water clarification: changes in waste management practices advisable. J. Clean. Prod. 218, 459–464.

Maroušek, J., Strunecký, O., Stehel, V., 2019b. Biochar farming: defining economically perspective applications. Clean Technol. Environ. Policy 1–7.

Marquis, C., Qian, C., 2014. Corporate social responsibility reporting in China: symbol or substance? Organ. Sci. 25 (1), 127–148.

Mcwilliams, A., Siegel, D.S., 2001. Corporate social responsibility: a theory of the firm perspective. Acad. Manag. Rev. 26 (1), 117–127.

Milward, R., Popescu, G.H., Michalikova, K.F., Musova, Z., Machova, V., 2019. Sensing, smart, and sustainable technologies in Industry 4.0: cyber-physical networks, machine data capturing systems, and digitized mass production. Econ. Manag. Financ. Mark. 14 (3), 37–43.

Mishra, D.R., 2017. Post-innovation CSR performance and firm value. J. Bus. Ethics 140 (2), 285–306.

Moon, Jeremy, Shen, Xi, 2010. CSR in China Research: Salience, Focus and Nature. Journal of Business Ethics 94 (4), 613–629.

Nidumolu, R., Prahalad, C.K., Rangaswami, M.R., 2009. Why sustainability is now the key driver of innovation. Harv. Bus. Rev. 87 (9), 56–64.

Nishimura, Junichi, Okamuro, Hiroyuki, 2011. Subsidy and networking: The effects of direct and indirect support programs of the cluster policy. Research Policy 40 (5), 714–727.

Ren, S., He, D., Zhang, T., Chen, X., 2019. Symbolic reactions or substantive pro-environmental behaviour? An empirical study of corporate environmental performance under the government's environmental subsidy scheme. Bus. Strat. Environ. (28), 1148–1165.

Sarkar, A., Singh, J., 2010. Financing energy efficiency in developing countries—lessons learned and remaining challenges. Energy Pol. 38 (10), 5560–5571.

Sharma, S., Vredenburg, H., 1998. Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities. Strat. Manag. J. 19 (8), 729–753.

Shu, C., Zhou, K.Z., Xiao, Y., Gao, S., 2016. How green management influences product innovation in China: the role of institutional benefits. J. Bus. Ethics 133 (3), 471–485.

Stehel, V., Vochozka, M., Kliestik, T., Bakes, V., 2019. Economic analysis of implementing VMI model using game theory. Oeconomia Copernicana 10 (2), 253–272.

Surroca, J., Tribo, J.A., Waddock, S., 2010. Corporate responsibility and financial performance: the role of intangible resources. Strat. Manag. J. 31 (5), 463–490.

Udell, M., Stehel, V., Kliestik, T., Kliestikova, J., Durana, P., 2019. Towards a smart automated society: cognitive technologies, knowledge production, and economic growth. Econ. Manag. Financ. Mark. 14 (1), 44–49.

Wagner, M., 2010. Corporate social performance and innovation with high social benefits: a quantitative analysis. J. Bus. Ethics 94 (4), 581–594.

Wang, X., Fan, G., Hu, L., 2019. NERI Index of Marketization of China's Provinces: 2018 Report. Social Sciences Academic Press (in Chinese).

Wang, Z., Sarkis, J., 2017. Corporate social responsibility governance, outcomes, and financial performance. J. Clean. Prod. 162, 1607–1616.

Yang, D., Wang, A.X., Zhou, K.Z., Jiang, W., 2018. Environmental strategy, institutional force, and innovation capability: a managerial cognition perspective.

J. Bus. Ethics 1–15.
Yang, Y., Chen, J., 2017. Do slack resources matter in Chinese firms' collaborative innovation? Int. J. Innov. Stud. 1 (4), 207–218.
Yi, Y., Liu, Y., He, H., Li, Y., 2012. Environment, governance, controls, and radical innovation during institutional transitions. Asia Pac. J. Manag. 29 (3), 689–708.
Zhang, Y., Yang, Z., Zhang, T., 2018. Strategic resource decisions to enhance the performance of global engineering services. Int. Bus. Rev. 27 (3), 678–700.
Zhou, Y., Li, X., Lema, R., Urban, F., 2016. Comparing the knowledge bases of wind turbine firms in Asia and Europe: patent trajectories, networks, and globalisation. Sci. Publ. Pol. 43 (4), 476–491.
Zhou, Y., Pan, M., Zhou, D.K., Xue, L., 2018. Stakeholder risk and trust perceptions in the diffusion of green manufacturing technologies: evidence from China. J. Environ. Dev. 27 (1), 46–73.
Zhou, Y., Zhang, H., Ding, M., 2015. How public demonstration projects affect the emergence of new industries: an empirical study of electric vehicles in China. Innov. Eur. J. Soc. Sci. Res. 17 (2), 159–181.