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CEO environmentally responsible leadership and firm environmental innovation: A socio-psychological perspective

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ABSTRACT

Manufacturing firms face increasing pressure to seek innovative solutions to environmental perils. Addressing such challenges requires responsible leadership that embraces a normative and stewardship approach for environmentally sustainable system. However, the question of whether and how CEO environmentally responsible leadership can drive firm environmental innovation has yet to be addressed. We develop and test a serial mediation model that specifies socio-psychological mechanisms through which environmentally responsible CEOs influence firm environmental innovation. To test the model, we use a two-wave multi-source dataset of top- and middle-level managers in 125 manufacturing firms in China. We find that environmentally responsible CEOs drive environmental innovation by developing a sense of collective environmental identification, which facilitates middle-level managers' engagement in the organizational citizenship behavior associated with a more sustainable environment. Our research delineates the power of CEOs' responsible leadership and its potential to help organizations that face growing pressure to increase environmental innovation.

1. Introduction

As concern about environmental issues increases, demand is growing for firms, particularly manufacturing firms, to act in a more environmentally responsible manner (Wagner, 2015). This demand propels firms and their leaders to adopt or develop innovative solutions to tackle environmental hazards, which can be broadly conceptualized as eco-innovation, defined as "innovation consist[ing] of new or modified processes, techniques, systems and products to avoid or reduce environmental damage" (Horbach, 2008, p. 163; see also Watson, Wilson, Smart, & Macdonald, 2018). Consistent evidence points to the positive performance implications of engaging in eco-innovation, such as reducing carbon emissions and improving financial performance (Lee & Min, 2015; Bitencourt, de Oliveira Santini, Zanandrea, Ladeira, & Frohelich, 2020).

Growing demand for eco-innovation and recognition of its potential benefits have led scholars to devote increased attention to the questions of what drives eco-innovation and how firms engage in eco-innovation (e.g., Brunnermeier & Cohen, 2003; Horbach, 2008; Watson et al., 2018). However, studies thus far have largely focused on the external pressures for eco-innovation, adopting either resource-based or institutional-based perspectives (Hojnik & Ruzzier, 2016). Although this focus is important, studies of internal forces, such as the roles of leaders and employees in facilitating eco-innovation (Ateş, Bloemhof, Van Raaij, & Wynstra, 2012), are limited. We address this issue and inform the literature of responsible leadership and eco-innovation by advancing a socio-psychological perspective to reveal mechanisms through which environmentally responsible leaders drive eco-innovation in manufacturing firms.

The notion of leadership driving organizational innovation may not be novel in itself (Jung, Chow, & Wu, 2003). However, while studies have focused on generic leadership–innovation performance outcomes (e.g., transformational leadership and organizational innovation), more recent research has sought to shift this conversation by advancing research on specific leadership behaviors (e.g., innovation leadership–innovation performance outcomes; Caridi-Zahavi, Carmeli, & Arazy, 2016; Donate & de Pablo, 2015; Liao & Zhang, 2020; Schneider, Ehrhart, Mayer, Saltz, & Niles-Jolly, 2005). We advance the latter perspective by theorizing that responsible leadership, defined as "the awareness and consideration of the consequences of one's actions for all stakeholders" (Voegtlin, Patzer, & Scherer, 2012, p. 4), is key to driving firm environmental innovation (e.g., Chen & Chang, 2013).

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We also advance a mechanism perspective to better understand the process through which environmentally responsible leadership and environmental innovation are achieved. We point to socio-psychological mechanisms that leaders cultivate in middle-level management, and explain how the latter group helps translate CEO responsible leadership into higher levels of firm environmental innovation. This is theoretically important because leadership theories demarcate the role of middle managers in translating leadership effort at the apex of the firm into better outcomes at various levels (Chen, Tang, Jin, Li, & Paillé, 2015; Robertson & Barling, 2013). Although theory on the role of middle-level management is well-developed, a systematic examination of middle-level management's influence on organizational environmental issues is lacking. We advance this stream of research by explaining why environmentally responsible CEOs facilitate middle-level managers' engagement in pro-environmental behaviors.

Drawing from social identity theory (Tajfel & Turner, 1979), we develop theorizing about why collective environmental identification [reflecting the shared sense of environmental responsibility within an organization (Raineri & Paillé, 2016)], can be interpreted as a positive reaction to leaders' concerns for the environment, and thus elicit extra-role discretionary action (Lee, Park, & Koo, 2015). Collective environmental identification strengthens employees' self-perception of being environmentally friendly, thus motivating them to engage in pro-environmental discretionary behavior, which is termed organizational citizenship behavior for the environment (OCBE). OCBE refers to "the discretionary acts not rewarded or required that are directed toward environmental improvement" (Daily, Bishop, & Govindarajulu, 2009, p. 246), and captures voluntary sustainable environmental protection behaviors. We further theorize that middle-level managers' involvement in OCBE is likely to drive firm environmental innovation. Fig. 1 depicts the conceptual model of the socio-psychological mechanism whereby CEOs' environmentally responsible leadership drives firm environmental innovation, through collective environmental identification and OCBE.

Our paper contributes to the literature in several ways. First, we advance the literature on leadership in general and responsible leadership in particular, as we extend the research on responsible leadership (Maak & Pless, 2006; Voegtlin et al., 2012; Voegtlin, Frisch, Walther, & Schwab, 2019) by examining how a specific leadership style pertains to environmentalism: CEO environmentally responsible leadership. Second, we examine whether CEO environmentally responsible leadership drives firm environmental innovation and, more importantly, reveal socio-psychological mechanisms by which this responsible leadership–firm environmental innovation link unfolds. We, thus, extend the research on how organizations and their leaders drive environmental innovation by shaping organizational members' perceptions of both their organization and environmental issues (Ou, Seo, Choi, & Hom, 2017). Specifically, we suggest that by interpreting and making sense of environmental issues, CEOs instill in members a sense of collective identification with environmental management (Sharma, 2000) and encourage middle-level managers to engage in activities that benefit the environment, often for their own sake (i.e., OCBE; Boiral & Paillé, 2012). This is important because firm-level choices and strategies are often translated into desirable outcomes by middle-level managers who are responsible for the day-to-day implementation of such practices (Chen, Jiang, Tang, & Cooke, 2018; Wooldridge, Schmid, & Floyd, 2008). Thus, by integrating the responsible leadership, social identity theory, and eco-innovation management literature, this paper deepens our understanding of why and how environmentally responsible CEOs drive environmental innovation in manufacturing firms. From a practical perspective, this endeavor is important by showing manufacturing firms and their leaders why and how addressing the growing demand for environmentally responsible management can yield positive performance outcomes.

2. Literature review

2.1. Environmental innovation

Innovation has attracted interest of both the communities of scholarship and practice, but only recently we have witnessed a growing attention towards environmental innovation (Kammerer, 2009), mainly because of the increasing demand for greater sustainability. Research in this area provides evidence in support of the positive implications of environmental innovation for the organizations, including improving organization reputation, attracting more employees and customers (de Jesus Pacheco et al., 2017), and enhancing organizational performance (Bitencourt et al., 2020). This emerging body of knowledge led scholars to further research on why and how organizations engage in environmental innovation (Bossle, de Barcellos, Vieira, & Sauvée, 2016), and point to the resource-based and institutional theories as key theoretical anchors in this endeavor (Hojnik & Ruzzier, 2016).

Despite their prominence in the literature, scholars noted that these "external drivers" do not necessarily propel organizations to engage in environmental innovation (Howard-Grenville, 2005), calling for further research which reveals alternative theoretical explanations. One perspective that is of particular interest shifts the discussion to internal stakeholders (del Río, Peñasco, & Romero-Jordán, 2016; Muller & Kolk, 2010), and advances research on internal processes and environmental leadership as key in driving organizations to implement environmental innovation (Salim, Ab Rahman, & Abd Wahab, 2019). This burgeons a key theoretical question concerning the mechanisms whereby environmental leadership and middle-level management's involvement drive environmental innovation.

2.2. Responsible leadership, environmentally responsible leadership, and environmental innovation

Responsibility is a key ingredient that constitutes effective leadership, but it has been largely overlooked for many years in the extant literature (Waldman & Galvin, 2008). In recent years, given the increasing calling to focus on the business ethic, the topic of responsible leadership has attracted considerable attentions among researchers and practitioners (Frangieh & Yaacoub, 2017). Maak and Pless (2006, p. 103) defined the responsible leadership as "a relational and ethical phenomenon that occurs in social processes of interaction with those who affect or are affected by leadership and have a stake in the purpose and vision of the leadership relationship". Responsible leaders are not only interested in the economic performance, but also emphasize the need to build an integrative system to include interests beneficial for both internal and external stakeholders (Maak & Pless, 2006). By acting as good citizens in an inclusive, respectful, and ethical manner, responsible leaders can shift the focus of a firm's sense of responsibility from internal stakeholders to external stakeholders and even to society (Maak & Pless, 2006), thus reconciling the organization's economic goals with the triple bottom line of economic growth, social equity, and environmental protection (Maak & Pless, 2006; Pless & Maak, 2011).

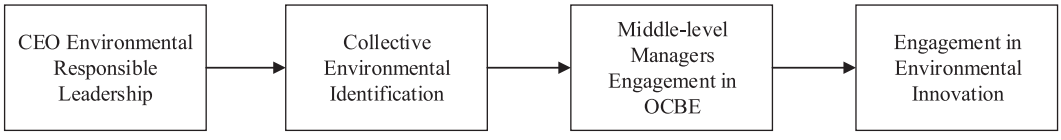

Fig. 1. Conceptual Model of the study.

In addition, beyond the link between generic leadership and generic outcomes (i.e. leadership and innovation), more and more studies began to investigate the effect of specific leadership type on specific outcomes. For example, Schneider et al. (2005) found that service-oriented leadership motivates customer-oriented OCB, and eventually leads to superior unit performance, and Caridi-Zahavi et al. (2016) examined how innovation leadership boosts firm innovation. Moreover, a recent review on the environmental innovation suggests that research on environmental innovation, as compared with general innovation, is relatively scarce (del Río et al., 2016). Therefore, in an attempt to advance this line of research, we offer a first attempt to explain why and how environmentally responsible leadership drives environmental innovation.

2.3. Managerial environmental concern and environmental innovation

Table 1 presents the summary of representative literatures regarding managers' involvement and environmental innovation. Sharma (2000) reported that managerial care for environmental issues is crucial for organizations to adopt pro-environmental practice, and these organizations are usually capable of initiating innovation to protect

Table 1
Summary of representative literatures regarding managers' involvement and environmental innovation.

No.	Author	Year of publication	Journal	Major findings	Theory	Method
1	Sharma	2000	Academy of Management Journal	Managerial interpretations of environmental issues are related to corporate choice of environmental strategy	–	Empirical study
2	Cordano & Frieze	2000	Academy of Management Journal	Environmental managers' attitudes about pollution prevention is positively related to behavioral preferences of environmental issues	Theory of planned behavior	Empirical study
3	Banerjee et al.	2003	Journal of Marketing	Four antecedents are important to corporate environmentalism: public concern, regulatory forces, competitive advantage, and top management commitment	Stakeholder theory	Empirical study
4	Zhu & Sarkis	2004	Journal of Operations Management	Internal environmental management is positively related to environmental performance	–	Empirical study
5	Bowen et al.	2006	In Greening the supply chain (pp. 151–172). Springer, London.	Middle managers' perception of corporate environmental proactivity is positively related to green supply initiatives implementation	–	Empirical study
6	Menguc et al.	2010	Journal of Business Ethics	The positive effect of entrepreneurial orientation on a PES is moderated by the intensity of government regulations and customers' sensitivity to environmental issues	Resource-based view and institutional and legitimacy theories	Empirical study
7	Muller & Kolk	2010	Journal of Management Studies	Management commitment to ethics is important driver of corporate social performance	Integrative social contract theory and stewardship theory	Empirical study
8	Qi et al.	2010	Journal of Cleaner Production	Managerial concern is the most important driver for the adoption of green practices	–	Empirical study
9	Chang	2011	Journal of Business Ethics	Corporate environmental ethics positively affects green product innovation and green process innovation	Institutional theory, stakeholder theory, RBV	Empirical study
10	Ateş et al.	2012	International Journal of Production Research	Proactive environmental strategy is positively related to environmental performance via environmental investments	Contingency theory	Empirical study
11	Chang & Chen	2013	Journal of Business Ethics	Corporate environmental ethics is positively related to competitive advantage through environmental innovation	Institutional theory, stakeholder theory, RBV	Empirical study
12	Liu et al.	2015	Management and Organization Review	This study compared studies conducted in Chinese and Western countries in terms of three antecedents: regulations, stakeholder norm, and managerial mindsets and proactive environmental strategy, and subsequent firm performance.	–	Meta-analysis review
13	Bossle et al.	2016	Journal of Cleaner Production	External factors and internal factors are important for the adoption of environmental innovation		Meta-analysis review
14	Mittal & Dhar	2016	Tourism Management	Green transformational leadership is positively related to green creativity through green organizational identity	–	Empirical study
15	Song & Yu	2018	Corporate Social Responsibility and Environmental Management	Green innovation strategy is positively related to green organizational identity and green creativity	Organizational identity theory	Empirical study
16	Salim et al.	2019	Journal of Cleaner Production	Internal capabilities pf manufacturing firms is helpful for enhancing environmental innovation	–	Meta-analysis review
17	Soewarno et al.	2019	Management Decision	Green innovation strategy is positively related to green innovation through green organizational identity and environmental organizational legitimacy	Organizational identity theory and Legitimacy theory	Empirical study
18	Zhao & Zhou	2019	Sustainabilty	Responsible leadership is positively related to OCBE through leader identification	Social identity theory	Empirical study
19	Afsar et al.	2020	Corporate Social Responsibility and Environmental Management	Responsible leadership is positively related to pro-environmental behavior through organizational commitment and green shared vision	Social identity theory	Empirical study
20	Liao & Zhang	2020	Corporate Social Responsibility and Environmental Management	Responsible leadership is positively related to environmental performance through environmental innovation; Managerial discretion moderates the relationship between responsible leadership and environmental innovation	Stakeholder and upper-echelon theories	Empirical study
21	Wang et al.	2020	International Journal of Hospitality Management	Dynamic capability, top managers' attitudes and stakeholder pressures are related to environmental innovation in the hotel industry	Institutional theory and stakeholder theory	Empirical study

environment (Hart, 1995). According to Salim et al. (2019)'s review, the internal cooperation across levels is crucial for organizations to adopt environmental innovation. The trickle-down effect of top leaders on the middle level managers with respect to their concerns toward environmental issue has thus attracted much attention in recent years. Prior literature even suggests that the managerial environmental concern "is perhaps the strongest determinant of environmental innovation strategy" (Bossle et al., 2016, p. 868; Chang, 2011; Qi, Shen, Zeng, & Jorge, 2010), indicating that incorporating the role played by managers' involvement in environmental issues is warranted (Ateş et al., 2012).

First, from the perspective of top managers, we have abundant knowledge about how desirable leadership style prompts environmental innovation. For example, Mittal and Dhar (2016) found that green transformational leadership leads to green creativity via green organizational identity. Liao and Zhang (2020)'s research demonstrated that responsible leadership is positively related to environmental innovation, and finally improves environmental performance. In addition, research has noted the role of top management support for adopting environmental friendly strategy and driving environmental innovation (e.g., Menguc, Auh, & Ozanne, 2010; Liu, Guo, & Chi, 2015; Wang, Font, & Liu, 2020). Expanding on the resource-based theory, top leaders who are concerned about environmental issues tend to perceive those environmental requirements as opportunity rather than threat, and thus they prefer to allocate resources to invest in the environmental management within organizations, and in turn facilitates environmental performance (Ateş et al., 2012; Banerjee, Iyer, & Kashyap, 2003; Menguc et al., 2010; Muller & Kolk, 2010). However, the mechanism by which top leaders drive environmental innovation remains unclear, especially the role played by other level employees' involvement.

Second, middle-level managers also play a vital role in this process, and Cordano and Frieze (2000) suggested that managerial support, in addition to those of top leaders, is important for organizations' environmental management. In fact, lower-level management and employees' awareness of environmental issues contribute to the success of implementing of environmental practices (Bowen, Cousins, Lamming, & Faruk, 2006). Middle-level management acts as bridges to link top leaders and first-level supervisors, so that they are able to interact with diverse employees, and thus influence the quality of top leaders' decision (Raes, Heijltjes, Glunk, & Roe, 2011), and these middle-level managers promote environmental management (Zhu & Sarkis, 2004) as well as influence innovation and strategy implementation (see Wooldridge et al., 2008).

Third, we draw on social identity theory to explain how the influence of CEOs and middle-level management unfolds in this process of driving environmental innovation. Ashforth and Mael (1989) defined the social identification as individuals' perception of their belonging towards an aggregation. Once employees identify themselves as a member of their organization, they tend to behave as the organizations advocate so as to sustain their membership (Riketta, 2005). Drawing on social identity theory, Chang and Chen (2013) found that green organizational identity is positively related to green innovation performance. In addition, the green identification serves as a mediator in the relationship between green innovation strategy and green innovation (Soewarno, Tjahjadi, & Fithrianti, 2019; Song & Yu, 2018). Further, others drew from social identity theory to explain the relationship between responsible leadership and pro-environmental behaviors (Afsar et al., 2020; Zhao & Zhou, 2019). However, most of these studies focused on employees' general identification with the organization and its influence on environmental performance. Here, we take a different stance and draw the social identity theory to highlight the environmental-specific identification of middle-level managers and their corresponding pro-environmental behaviors in connecting top leaders' environmentally responsible leadership and environmental innovation.

3. Hypotheses development

3.1. CEO environmentally responsible leadership, collective environmental identification, and middle-level managers' engagement in OCBE

We posit that environmentally responsible CEOs drive eco-innovation by instilling a sense of collective environmental identification in middle managers and fostering engagement in OCBE. We argue that environmentally responsible CEOs are likely to foster middle-level managers' engagement in environmental innovation by instilling a collective sense of environmental identification. As a bridge between top managers and front-line employees, middle-level managers can convert top managers' environmental strategies and orientations into the day-to-day processes and activities of front-line employees (Raes et al., 2011), which may influence the organization's environmental performance (Boiral, Talbot, & Paillé, 2015).

Environmentally responsible CEOs provide the resources and support needed for environmental initiatives (Ramus & Steger, 2000). For example, environmentally responsible CEOs tend to communicate a clear vision on environmental issues to middle-level managers, thus driving their engagement in environmental-related activities (Liao & Zhang, 2020; Daily et al., 2009). Environmentally responsible CEOs also serve as role models for environmental protection (Jung et al., 2003), thus shaping middle-level managers' perceptions of and attitudes toward related activities. Responsible leaders coach and train middle-level managers to take on environmentally sustainable activities by developing a more inclusive perspective on results that takes into account the benefits to all stakeholders (Maak & Pless, 2006). Environmentally responsible leadership also provides situational cues for the development of environmentally friendly strategies and policies, making middle-level managers more willing to work to achieve a more environmentally sustainable system (Chen et al., 2015; Raineri & Paillé, 2016).

We suggest that the influence of environmentally responsible leaders on the OCBE of middle-level managers unfolds through a social identification process. Social identification refers to the "perception of oneness with or belongingness to some human aggregation" (Ashforth & Mael, 1989, p. 21). This social identity process allows members to define their individual self-image and self-conception (Prayag, Mills, Lee, & Soscia, 2019). In this study, we shift the discussion and focus on collective identification, group members' shared sense of identification with a work group (Van Der Vegt & Bunderson, 2005). Collective environmental identification captures "a sense of attachment and responsibility to environmental concerns in the workplace" (Raineri & Paillé, 2016, p. 133).

CEOs instill a sense of environmental identification by communicating a vision and setting values that underscore the importance of environmental responsibility. They communicate their vision by creating consistency between organizational goals and shared values (Shamir, Zakay, Brainin, & Popper, 2000). They also model environmentally responsible actions by skillfully using slogans, symbols, and ceremonials events associated with environmental protection that underscore the value of environmentally responsibility, thus shaping members' collective identity and, thereby, their engagement (Shamir et al., 2000). CEOs instill a sense of collective identification by acting in more inclusive ways (e.g., using "us" rather than "me" language) (Shamir et al., 2000). Extending the research by Van Knippenberg, Van Knippenberg, De Cremer, and Hogg (2005) on leadership and social identification and the research on responsible leadership, we argue that environmentally responsible CEOs tend to desire that employees prioritize environmental interests over profit for the benefit of society (Maak & Pless, 2006). CEOs can enact this social identification process by providing situational cues that help followers understand organizational values and vision and cultivate strong identification with the organization (Hogg & Van Knippenberg, 2003), thus fostering their engagement

in corresponding activities. CEOs who underscore environmental concerns add meaning to members' environmentally responsible actions (Robertson & Barling, 2013), giving followers the opportunity to achieve self-enhancement while benefiting society.

We suggest that identification is key to OCBE engagement. Research has shown that employees with high levels of organizational identification are more willing to take charge (Li, Zhang, & Tian, 2016); thus, organizational identification is considered an important predictor of general OCB (Zhang & Chen, 2013). Consistent with social identity theory (Tajfel & Turner, 1979) and the group engagement model (Tyler & Blader, 2001), we reason that acting in responsible ways creates positive experiences (i.e., feelings of pride), motivating members to engage voluntarily in such behaviors (Tyler & Blader, 2001). Environmental identification fosters engagement in discretionary environmentally friendly behaviors, i.e., eco-engagement (Boiral & Paillé, 2012). Hence, we expect that when CEOs instill a sense of environmental responsibility within organizations, it will be easier to achieve collective identification between organizational members and to encourage middle-level managers to engage in environmentally friendly activities. Thus,

Hypothesis 1. Environmentally responsible leadership is indirectly and positively related to middle-level managers' engagement in OCBE through collective environmental identification.

3.2. Middle-level managers' engagement in OCBE and firms' engagement in environmental innovation

We posit that middle-level managers' engagement in OCBE facilitates environmental innovation. OCBE consists of three dimensions—eco-initiatives, eco-civic engagement, and eco-helping (Boiral & Paillé, 2012)—which are key to the development of environmental innovation. Eco-initiatives require middle-level managers to consider environmental issues when making decisions and carrying out day-to-day activities. Engaged managers develop innovative approaches to ensure more environmentally responsible actions and products, often by harnessing their colleagues' efforts. Eco-civic engagement in OCBE enables middle-level managers to participate more actively in decision-making processes and actions related to environmental issues (Boiral & Paillé, 2012). Middle-level managers engaging in eco-civic activities contribute positively to their organization's environmental image. As unit leaders, their eco-civic behaviors encourage other organizational members to introduce or modify work processes that improve the organization's environmental performance (Andersson & Bateman, 2000). Middle-level managers who engage in eco-helping are likely to help their colleagues adopt more environmentally conscious behaviors (Boiral & Paillé, 2012), thus creating a more supportive and collaborative work environment for environmental protection (Ferreira, Braun, & Sydow, 2013), which will lead to new solutions to environmental problems. Thus,

Hypothesis 2. Middle managers' engagement in OCBE is positively related to firms' engagement in environmental innovation.

Based on the above arguments, we specify a serial mediation model in which environmentally responsible CEOs drive firms' engagement in environmental innovation by instilling a sense of collective environmental identification and cultivating the engagement of middle-level management in OCBE. We reason that environmentally responsible CEOs play a key role in shaping a positive environmental identity in employees who strive to find meaning and significance in their organizational membership. This identification process is the primary motivational driver of middle managers' engagement in OCBE. Through such engagement, middle-level managers harness their units' capacity to develop environmentally responsible solutions to their organizations' environmental problems. Thus,

Hypothesis 3. Environmentally responsible leadership is indirectly and positively related to firms' engagement in environmental innovation and is sequentially mediated through collective environmental identification and middle managers' engagement in OCBE.

4. Method

4.1. Research design

We collected data from manufacturing firms in northeastern China (i.e., Inner Mongolia and Jilin). This setting was selected because firms in this region are widely perceived as highly damaging to the environment (Meng, Zeng, Xie, & Qi, 2016). Northeastern China has a traditional manufacturing base in the fields of energy, machinery, and pharmaceuticals, and environmental issues in this region are more serious than in other regions of China. The Chinese government has responded to the problem of pollution by implementing various legislative regulations that require domestic firms to solve the increasing challenges of environmental management. Thus, a study of firms' attitudes toward environmental protection in this region is relevant and will help Chinese firms improve their environmental management (Zhu & Sarkis, 2004).

We utilized the professional network of one of the authors to connect with Chinese companies. As most Chinese companies use a high-context communication style in which most business information is found in a physical context or internalized in a person (Takeuchi, Lepak, Wang, & Takeuchi, 2007), we considered it important to use personal contacts to improve the response rate. We sought the assistance of local government officers who were able to request data from the firms that fell under their jurisdiction (Davies & Walters, 2004). To obtain a sample that was representative of local conditions, we used a probability sampling approach based on random selection from a list of 350 manufacturing firms (Chen et al., 2018; Davies & Walters, 2004). After deleting firms that failed to agree to participate in our survey, we finally include 267 firms as sample. These were predominantly small to medium-sized and state-owned firms, and the sample was representative of the target population based on age, size, ownership structure, and industry affiliation. These targeted firms were located in the energy, machinery, and pharmaceutical fields, which are considered to be pollution-heavy. Environmental protection innovation is a priority for firms seeking to improve firm performance (Chen et al., 2018).

To minimize the single-rater bias (Gerhart, Wright, Mahan, & Snell, 2000), we used a multi-source data collection procedure. The final sample included only firms that provided data for both top team management (TMT) members and middle managers. TMT members in this study were defined as CEOs and top executives who reported directly to their CEOs, such as chief information officers (CIOs), chief marketing officers (CMOs), and senior HR managers (Chen, Tang, Lee Cooke, & Jin, 2016). As the power of middle managers may vary with firm size, we followed Wooldridge et al. (2008) in defining middle managers as department and/or unit heads in functionally organized small to medium-sized firms (e.g., marketing and communication managers), and as the organizational layer above the supervisory level but below the TMT member level in large firms (e.g., functional managers, department heads, and line managers). Respondents in different positions were invited to complete the survey items with which they were most knowledgeable (Chen et al., 2016).

The data were collected at two points in time one year apart to minimize the potential for common method variance and to enable identification of causal relationships in our model. At Time 1, we collected the data by administering a structured survey onsite. One of the authors visited the work site and informed the participants about the objectives of the survey, described the voluntary nature of their participation, guaranteed the anonymity of their responses, and provided a gift (e.g., business management books) as an incentive for participating in the study. In the survey, 288 members of the top management team provided information regarding their CEO environmentally responsible leadership, 144 CEOs provided information about their firms'

environmental performance and demographic characteristics (e.g., firm size, firm age, ownership structure, and industry type), and 353 middle managers provided information about collective environmental identification and their engagement in OCBE. All of the surveys were completed by the respondents and collected by one of the authors onsite on the same day. At Time 2, one TMT member per firm (not the CEO) was invited to participate in a phone interview in which they were asked about firm environmental innovation. Overall, we obtained 130 responses from TMT members in this phase.

In consideration of the confidentiality policy of some firms and incomplete responses, we excluded questionnaires with missing values. The final matched sample between two waves yielded 125 firms, producing a final response rate of 46.82% (=125/267). We considered this response rate acceptable, as it exceeded those in other firm-level studies, which ranged from 6% to 28% (Becker & Huselid, 1998). Table 2 presents a summary of our sample. As shown in Table 2, small to medium-sized firms accounted for 86.4% of the respondent firms, and state-owned firms accounted for 68.0% of these firms. We received responses from 125 CEOs, 250 TMT members, and 305 middle managers. On average, 2 TMT members and 2.44 middle managers responded from each firm. To test for non-response bias, we compared a sample of 50 matched firms with a sample of unmatched firms for which we had data on firm age and number of employees (De Luca & Atuahene-Gima, 2007). Analyses of variance showed that the F-value on firm age was 0.50 and that on number of employees was 0.42, indicating that there were no significant differences between these two groups. We also conducted an additional non-response test to compare the differences across the two waves. We compared the final sample of 125 firms with the firms that dropped out during the second wave but reported data on firm age, firm size, ownership structure, CEO's environmentally responsible leadership, collective environmental identification, middle-level managers' engagement in OCBE, and environmental performance; the analyses of variance showed that there were no significant differences between the two groups in terms of firm age ($F = 0.64$, *n.s*), firm size ($F = 0.00$, *n.s*), ownership structure ($F = 0.17$, *n.s*), CEO environmentally responsible leadership ($F = 0.55$, *n.s*), collective environmental identification ($F = 0.04$, *n.s*), middle-level managers' engagement in OCBE ($F = 0.03$, *n.s*), and environmental performance ($F = 0.10$, *n.s*). Thus, we concluded that non-response bias was not a serious problem in our study.

Table 2
Sample Characteristics (N = 125).

	Frequency	Percent (%)
Firm size (no. of employees)		
<100	35	28.0
100–1000	73	58.4
More than 1000	17	13.6
Ownership structure		
State owned	85	68.0
Non-state owned	40	32.0
Industry type		
Basic metal	30	24.0
Non-metallic mineral	28	22.4
Fabricated metal	7	5.6
Machinery equipment	16	12.8
Chemicals	6	4.8
Thermal power	11	8.8
Energy	9	7.2
Mining	6	4.8
Building materials	12	9.6
Firm age (in years)		
Less than or equal to 5	22	17.6
6–10	51	40.8
More than 10	52	41.6

4.2. Measures

We followed Brislin (1986) and used the back-translation technique to translate the questionnaires from English into Chinese. The initial draft of the Chinese questionnaires was reviewed by the second author and another Chinese management faculty member who was proficient in English. They made some minor changes to the item wording to increase the content validity and clarity of the instructions (Chen et al., 2018). Unless otherwise specified, all of the multi-item measures used a 5-point Likert response format (from 1 = strongly disagree to 5 = strongly agree).

CEO environmentally responsible leadership. Robertson and Barling (2013) developed a 7-item scale based on the multifactor leadership questionnaire (Avolio & Bass, 1995), in which the measurement items reflect all four aspects of responsible leadership and its influence on environmental sustainability. In this study, the 7-item scale was used to measure CEO environmentally responsible leadership. TMT members (excluding CEOs) were asked to indicate how frequently each item described their leaders' behavior (from 1 = not at all to 5 = frequent, if not always). A sample item is "My leader talks about his/her values and beliefs about the environment" ($\alpha = 0.88$).

Collective environmental identification. A 7-item scale from Raineri and Paillé (2016) was used. Middle managers were asked to rate the degree to which the statements accurately described the attitudes of the companies' employees toward their firms' environmental practices. A sample item is "The environmental concern of our company has a great deal of personal meaning for us" ($\alpha = 0.84$).

Middle managers' engagement in OCBE. A 10-item scale developed by Boiral and Paillé (2012) was used to measure this variable. Middle managers were asked to rate statements on their own OCBE in the workplace. A sample item is "In my work, I weigh up my actions before doing something that could affect the environment." As we conceptualized middle managers' engagement in OCBE as a reflective second-order variable, we used the AMOS 7 software package to perform second-order confirmatory factor analysis (CFA) to assess the homogeneity of these three facets. Following Koufteros, Babbar, and Kaighobadi (2009) suggestions, we examined four models in the context of the measurement model. In the first model, we specified middle managers' engagement in OCBE as a first-order variable. In the second model, we specified the three first-order variables as uncorrelated. The third model specified these three first-order variables as correlated. In the fourth model, we specified middle managers' engagement in OCBE as a reflective second-order variable with the three first-order variables. The four models were compared by calculating the significance of the differences in χ^2 values, and we found that lower χ^2 values were favored. Model 1 produced a $\chi^2_{(35)} = 78.34$, whereas Model 2 had a $\chi^2_{(35)} = 188.22$. The $\Delta\chi^2$ was 109.88, which was statistically significant at $p < 0.01$, indicating that Model 1 was favorable. Model 3 produced a significantly lower value ($\chi^2_{(32)} = 54.65$) than Model 1, and the difference ($\Delta\chi^2 = 23.69$) was statistically significant ($p < 0.01$). Model 4 produced the same χ^2 values as Model 3, suggesting model equivalence based on model fit. The values of TLI, CFI, and RMSEA in Model 3 were also the same as in Model 4 (i.e., TLI = 0.93, CFI = 0.95, RMSEA = 0.076).[1] Considering for the standard of parsimony, and based on statistical findings, we considered the second-order variable of middle managers' OCBE to be the best model (Koufteros, Verghese, & Lucianetti, 2014). ($\alpha = 0.84$).

Engagement in environmental innovation. A 3-item scale adopted by Molina-Castillo, Jimenez-Jimenez, and Munuera-Aleman (2011) was used to measure firms' innovation in environmental protection. One top

[1] In this study, we used the overall model's chi-square, Tucker-Lewis index (TLI), comparative fit index (CFI), and root mean square error of approximation (RMSEA) to assess the model fit (Chen et al., 2018; Hair, Black, Babin, Anderson, & Tatham, 2010).

manager from each firm was asked to indicate the importance to their firms of environmental product development over the last three years. A sample item is "We have upgraded skills in environmental product development processes where the firm already possesses significant experience" (α = 0.70).

Control variables. We introduced several firm and team characteristics as control variables, as multiple firm characteristics, such as firm age, size, ownership structure, industry subtype, and environmental performance, could be associated with collective environmental identification, middle managers' OCBE, and engagement in environmental innovation. We controlled for firm age by taking the natural logarithm of the years since the firm was established. We controlled for firm size by taking the natural logarithm of the number of the firm's employees. We controlled for ownership structure using a dummy variable (1 = state owned firms and 0 = non-state-owned). We controlled for industry subtypes, as firms with different subtypes may have different environmental impacts. We coded eight industry dummies (1 = basic metal; 2 = nonmetallic mineral; 3 = fabricated metal; 4 = machinery equipment; 5 = thermal power; 6 = chemicals; 7 = energy; and 8 = mining) to control for potential industry effects (Chen et al., 2018).

Finally, we controlled for environmental performance by adopting a 4-item scale from Judge and Douglas (1998). CEOs were asked to compare their firms' environmental performance with their competitors over the past 2–3 years (Wade & Hulland, 2004). A sample item is "Our firm is limiting its environmental impact beyond regulatory compliance" (from 1 = far below the average to 5 = far above the average) (α = 0.87), indicating acceptable measurement reliability. Public data on firm performance were difficult to collect from our respondent firms, so to provide some assurance regarding the validity of the CEOs' subjective rating of their environmental performance, we followed Chen et al. (2015) and invited the firms' external stakeholders to participate in our project. For each firm, we asked a local stakeholder, such as a supplier, customer, shareholder, or local government official, to rate the firm's environmental performance. We first asked the stakeholders to rate the extent to which they were familiar with the firm they were rating (1 = not familiar at all to 5 = very familiar). All of the ratings were above 3, indicating that all of the stakeholders were familiar with the firms. Next, they were asked to evaluate the firm's environmental performance, using the same scale as the CEOs (Judge & Douglas, 1998) (α = 0.80). The correlation between the evaluations of environmental performance from stakeholders and the CEOs was positive and significant ($r = 0.29$, $p < 0.01$), indicating that the subjectiveness of the CEOs' rating of their own firms' environmental performance was not a serious concern.

Appendix A summarizes the point when the data were collected, measurement sources, response sources, and the mode by which the data were collected.

5. Data analysis

5.1. Common method variance

Although the variables of interest were reported from different sources, common method bias was still a possible problem. Following Podsakoff, MacKenzie, and Podsakoff (2012), we took action to remedy the common method variance during data collection. One of authors visited the work sites to explain our research purpose and to ensure the anonymity and confidentiality of the respondents. We also used different sets of instructions for each construct, put several filler items in between the constructs, and then placed them in different parts of the survey. After data collection, we conducted Harman's one-factor test by using principal factor analysis with Varimax rotation, and multiple factors with Eigenvalues greater than 1 were extracted, with the first factor accounting for 28.57% of the total variance explained (63.01%). Thus, common method variance did not appear to be a problem in this study.

5.2. Endogeneity

As prior research has suggested, omitted variables and/or feedback loops may result in endogeneity (Benitez, Castillo, Llorens, & Braojos, 2018). Therefore, we conducted a series of Hausman tests to examine whether endogeneity potentially influenced our proposed relationships. We then examined the effects of CEO environmentally responsible leadership on collective environmental identification, collective environmental identification on middle-level managers' engagement in OCBE, and middle-level managers' engagement in OCBE on engagement in environmental innovation by incorporating competitive intensity as an instrumental variable. The Hausman tests revealed that the above models were unaffected by endogeneity ($\Delta\chi^2 = 0.50$, *n.s*; $\Delta\chi^2 = 0.10$, *n.s* and $\Delta\chi^2 = 0.85$, *n.s*), indicating that omitted variables are not a problem in these relationships. As data on collective environmental identification and middle-level managers' engagement in OCBE were collected from middle managers, we examined whether reverse causality exists in our study. We examined model fit by comparing the values of Akaike's information criterion (AIC) and the Bayesian information criterion (BIC) between our hypothesized model and the alternative models (Kline, 2011). According to Kline (2011), smaller values indicate better model fit and a higher possibility of replication. The results showed that the fit indices for our hypothesized model (AIC = 106.56, BIC = 112. 88) were better than the reverse causal model in which middle-level managers' engagement in OCBE was set to predict collective environmental identification (AIC = 112.00, BIC = 118.33). Therefore, reverse causality is not a problem in our model.

5.3. Aggregation tests

To support the aggregation of CEO environmentally responsible leadership, collective environmental identification, and middle managers' OCBE, we calculated their inter-member reliability. To test inter-member reliability, we calculated ICC (1), the proportion of variance in the rating caused by team membership, and ICC (2), the reliability of the team mean differences (Bliese, 2000). We also tested whether the average scores were significantly different across teams by calculating the F-test using a one-way analysis of variance. For CEO environmentally responsible leadership, the results for the aggregation were as follows: ICC (1) = 0.17; ICC (2) = 0.29; $F = 1.42$, $p < 0.05$. For collective environmental identification, the results for aggregation were as follows: ICC (1) = 0.20; ICC (2) = 0.37; $F = 1.60$, $p < 0.01$. For middle managers' engagement in OCBE, the results for aggregation were as follows: ICC (1) = 0.28; ICC (2) = 0.48; $F = 1.93$, $p < 0.01$. The values for these two variables exceeded the value of 0.12 suggested by James (1982). However, both of the ICC (2) values were lower than the accepted cutoff of 0.60 (Glick, 1985). ICC (2) is a function of team size (number of employees) (see Bliese, Halverson, & Schriesheim, 2002), and the average TMT size in this study was 3.60, which was not large enough to generate ICC (2) values as high as those in other studies. This problem has been identified in other management studies (e.g., Srivastava, Bartol, & Locke, 2006). Accordingly, we concluded that the within-team ratings were sufficiently homogeneous to be aggregated.

5.4. Measurement model

We used AMOS 7 to perform CFAs to examine the convergent validity of the multiple-item variables. We examined a 4-factor model that included CEO environmentally responsible leadership, collective environmental identification, middle managers' engagement in OCBE, and engagement in environmental innovation. As our sample size was small relative to the number of measurement items, we created three indicators for each single-dimension construct, following procedures suggested by Hui, Lee, and Rousseau (2004). The model was shown to have an acceptable fit to the data: $\chi^2_{(48)} = 50.57$, $p < 0.01$; CFI = 0.99, TLI = 0.99, and RMSEA = 0.021. In addition, all of the factor loadings

were significant, indicating convergent validity.

We tested the discriminant validity of the four key variables by comparing the 4-factor CFA model with alternatives (e.g., Liu, Lee, Hui, Kwan, & Wu, 2013; Wu, Birtch, Chiang, & Zhang, 2018). Table 3 shows the results of the model comparison and the 4-factor model fits the data considerably better than any of the alternatives, supporting the distinctiveness of the four variables used in this study. Table 4 reports the descriptive statistics and correlation matrix.

6. Results

Test of mediation. To test the significance of the mediation effects, we used Preacher and Hayes (2008) method to calculate the standard errors and the 95% confidence intervals (CIs) of the indirect effects. Preacher and Hayes (2008) pointed out that their approach addresses mediation more directly and thus is more powerful than the traditional procedure proposed by Baron and Kenny (1986). In our hypothesis tests, we applied the Statistical Package for the Social Sciences macro developed by Preacher and Hayes (2008), which uses a bootstrapping approach to estimate the indirect effects (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002).

Table 5 presents the results of the sequential mediation test of collective environmental identification and middle managers' engagement in OCBE. First, CEO environmentally responsible leadership was positively related to collective environmental identification, as indicated by a significant unstandardized regression coefficient ($\beta = 0.22$, $t = 2.92$, $p < 0.01$) that was statistically different from zero (Preacher & Hayes, 2008). A positive and significant relationship was also found between collective environmental identification and middle managers' engagement in OCBE ($\beta = 0.52$, $t = 7.47$, $p < 0.01$). To confirm the mediation results, we used the bootstrapping method, which typically uses 5000 bootstrapped samples to estimate the bias-corrected and accelerated CIs (MacKinnon et al., 2002). The findings indicated that CEO environmentally responsible leadership had an indirect effect on middle managers' engagement in OCBE. The indirect effect was 0.11 with a bootstrapped 95% CI around the indirect effect that did not contain zero [0.04, 0.20]. Thus, Hypothesis 1 was supported. Table 5 also shows that middle managers' engagement in OCBE was positively related to engagement in environmental innovation ($\beta = 0.58$, $t = 2.66$, $p < 0.01$). Thus, Hypothesis 2 was supported. These findings indicated that CEO environmentally responsible leadership had an indirect effect on engagement in environmental innovation. The indirect effect was 0.07, with a bootstrapped 95% CI around the indirect effect that did not contain zero [0.01, 0.16]. Thus, Hypothesis 3 was supported.

Finally, to confirm the results, we conducted structural equation modeling using the AMOS 7 software. As shown in Fig. 2, all of the paths were significant at $p < 0.01$.[2] The model showed an acceptable fit to the data: $\chi^2/\text{d.f.} = 1.05$, $p < 0.01$; CFI = 0.99, TLI = 0.99, RMSEA = 0.021, thus supporting Hypothesis 3.

Table 3
Results of Confirmatory Factor Analysis for the Measures of the Variables Studied.

Model	χ^2	*Df*	$\Delta\chi^2$	TLI	CFI	RMSEA
Four-factor model	50.57	48		0.99	0.99	0.021
Three-factor model-1: CEO environmentally responsible leadership and collective environmental identification combined	239.05	51	188.48**	0.58	0.68	0.172
Three-factor model-2: CEO environmentally responsible leadership and middle-level managers' engagement in OCBE combined	213.64	51	163.07**	0.64	0.72	0.160
Three-factor model-3: CEO environmentally responsible leadership and engagement in environmental innovation combined	127.85	51	77.28**	0.83	0.87	0.110
Three-factor model-4: Collective environmental identification and middle-level managers' engagement in OCBE combined	73.32	51	22.75**	0.95	0.96	0.059
Three-factor model-5: Collective environmental identification and engagement in environmental innovation combined	116.34	51	65.77**	0.85	0.89	0.102
Three-factor model-6: Middle-level managers' engagement in OCBE and engagement in environmental innovation combined	103.21	51	52.64**	0.88	0.91	0.091
One-factor model	299.88	54	249.31**	0.48	0.58	0.192

Note: TLI is the Tucker-Lewis index; CFI is the comparative fit index; and RMSEA is the root-mean-square error of approximation.
** $p \leq 0.01$, * $p \leq 0.05$.

7. Discussion

Environmental innovation is vital for firms and for society (Watson et al., 2018). In this study, we explored the mechanisms through which CEOs' environmentally responsible leadership drives firms' engagement in environmental innovation. By using matched samples of CEOs, TMTs, and middle-level managers from Chinese manufacturing firms, collected in two waves, we developed a socio-psychological mechanism model to shed light on how environmentally responsible CEOs drive a firm's engagement in environmental innovation, through collective environmental identification and middle managers' engagement in OCBE.

Research suggests that leadership is conducive for bolstering innovation (Rosing, Frese, & Bausch, 2011). However, research linking a specific leadership style (environmental responsible leadership) to a specific performance outcome (environmental innovation) has only recently been advanced in the literature (Caridi-Zahavi et al., 2016; Schneider et al., 2005). Advancing a responsible leadership lens, our research delineates the conditions that environmentally responsible CEOs develop and cultivate to bolster eco-innovation in manufacturing firms. In so doing, we enhance our understanding of the power of responsible leadership in general (Tsui, 2019; Maak & Pless, 2006; Waldman & Galvin, 2008) and the mechanisms through which they positively influence environmental innovation in particular (Liao & Zhang, 2020).

The results also reveal that middle-level managers can help translate CEO environmentally responsible leadership into desired outcomes (e.g., eco-innovation). This finding addresses a research gap identified by Maak and Pless (2006), who called for study on the relationship between responsible leadership and followers' behaviors (middle managers in this study). This finding expands on previous research and highlights the role of middle-level managers in transforming firms' strategic formulations into reality (Wooldridge et al., 2008; Huy, 2001). It also highlights the importance of the socio-psychological process through which middle managers become more engaged pro-environment behaviors (Tian &

[2] Differences between the estimated coefficients in the regression analysis and SEM may be due to different estimation approaches (ordinary least squares versus maximum likelihood) or because the regression analysis did not account for measurement errors (De Luca & Atuahene-Gima, 2007).

Table 4
Means, Standard Deviations, and Correlations.

Variables	1	2	3	4	5	6	7	8
1. Firm age (log)	–							
2. Firm size (log)	−0.04	–						
3. Ownership structure	0.36**	0.02	–					
4. Environmental performance	0.01	−0.03	−0.05	***(0.87)***				
5. CEO environmentally responsible leadership	0.06	0.00	−0.04	0.24**	***(0.88)***			
6. Collective environmental identification	0.01	−0.07	−0.01	0.16	0.26**	***(0.84)***		
7. Middle-level managers' engagement in OCBE	−0.07	−0.12	0.06	0.11	0.22*	0.64**	***(0.81)***	
8. Engagement in environmental innovation	−0.03	−0.11	−0.05	0.12	0.11	0.19*	0.35**	***(0.70)***
Mean	2.35	5.35	0.68	4.21	3.96	4.01	3.82	4.15
SD	0.75	1.13	0.47	0.70	0.45	0.37	0.33	0.59

Note: $N = 125$; Coding: 'state owned' = 1; 'non-state owned' = 0.
Cronbach's alpha appears along the diagonal in the brackets.
** $p \leq 0.01$.
* $p \leq 0.05$.

Robertson, 2019), as collective organizational identification facilitates their organizational citizenship behavior toward the environment. Most research on organizational identification has been conducted at the individual level (see Riketta, 2005), but we shift the focus to collective organizational identification and explain why it can positively influence organizational citizenship behaviors toward the environment (Van Dick, Grojean, Christ, & Wieseke, 2006). Finally, the findings indicate a positive relationship between OCBE and engagement in environmental innovation, thus providing further evidence of the positive influence of OCB on innovation (Andersson & Bateman, 2000; Yan & Yan, 2013).

7.1. Theoretical implications

This research makes several theoretical contributions to the literature. First, we contribute to the literature on eco-innovation by demonstrating why and how a leadership perspective can inform the processes and mechanisms that underpin environmental innovation (Chen et al., 2015). Recent studies have called for research on the link between specific forms of leadership and specific desired outcomes (e.g., Caridi-Zahavi et al., 2016), but this line of research has been slow to develop, both theoretically and empirically. We answer this call by developing a process model to explain whether and how responsible leadership can bolster environmental innovation in manufacturing firms. We conceptualize environmentally responsible leadership as a set of specific responsible leadership behaviors to drive eco-innovation. We identify the crucial roles of environmentally responsible CEOs, organizational members, and middle-level managers. Thus, our findings are informative regarding the participants and processes that contribute to eco-innovation (Alfred & Adam, 2009).

Secondly, we contribute to the responsible leadership literature by using a socio-psychological perspective to identify mechanisms through which environmentally responsible CEOs drive environmental innovation. Responsible leaders emphasize building sustainable relationships between all stakeholders (Maak & Pless, 2006). Different from the perspective on how external stakeholders' pressure forces organizations to engage in environmental innovation, our study identifies the process through which environmentally responsible CEOs mobilize internal stakeholders such as middle managers to become involved in environmental innovation (Doh & Quigley, 2014; Voegtlin et al., 2012). By focusing on the role played by organizational members, we reveal a sequential mechanism that moves from collective environmental identification to middle managers' engagement in OCBE. Our study thus provides insights into the socio-psychological processes through which CEO environmentally responsible leadership drives environmental innovation.

Our third contribution is the introduction of social identity theory to the study of eco-innovation. Specifically, we investigate collective environmental identification as an intermediate variable through which CEO environmentally responsible leadership improves firms' engagement in environmental innovation. Social identity theory has been widely used to explain how leaders foster subordinates' pro-organizational behaviors by developing self-concepts within organizations (Van Knippenberg et al., 2005), but most studies have focused on individual-level identification processes and overlooked the question of who or what is being identified with. We move beyond the general link between social identity and following behaviors at the organizational level (Zhang & Chen, 2013) and investigate why and how environmentally responsible CEOs who demonstrate concern and accountability can be instrumental in enhancing environmental innovation. We find that environmentally responsible CEOs tend to allocate resources and provide support that is aligned with their environmentalist vision and initiatives (Ramus & Steger, 2000), and that this attitude permeates the organization and encourages middle managers to embrace pro-environmental behaviors (Chen et al., 2015). Thus, our study provides researchers with insights into the power of collective organizational identification with environmental issues and middle managers' proactive engagement in OCBE.

Finally, we contribute the literature by revealing the mechanisms underlying middle-level managers' pro-environmental behaviors, thus enriching our understanding of responsible leadership and eco-innovation. Wooldridge et al. (2008) argue that middle-level managers play an important role in the specific processes that transform firms' strategic formulations into reality, but the relationship with responsible leadership in eco-innovation contexts remain unclear. Extending the notion that OCBE drives environmental advantage (Boiral & Paillé, 2012), we explore whether and how environmentally responsible CEOs motivate middle managers to engage in OCBE, which offers a potential way to resolve divergences on innovation decisions between senior managers and middle managers. This study shows the value of middle-level managers' OCBE in transforming top managers' pro-environmental leadership style into real environmental innovation.

7.2. Practical implications

Our findings have a number of practical implications. First, we highlight the importance of recruiting and developing environmentally responsible leaders because of their positive influence on desired outcomes, such as environmental innovation. To be environmentally responsible leaders, CEOs could consider developing products or services that are "greener" than existing products and establishing more certifiable environmental management systems. Second, our findings show that environmentally responsible CEOs can achieve environmental innovation by improving employees' environmental identification. One way to achieve this goal is to develop a supportive learning climate that encourages employees to understand and identify with an organization's environmental vision. For example, firms could offer rewards to

Table 5
Regression Results for Mediations.

Model	Coefficients	Standard error	T-value	P-value	Confidence interval	
					Lower	Upper
Outcome: collective environmental identification						
Constant	3.13	0.36	8.68	0.00	2.41	3.84
CEO environmentally responsible leadership	0.22	0.07	2.92	0.00	0.07	0.37
Firm age (log)	−0.01	0.05	−0.14	0.89	−0.11	0.09
Firm size (log)	−0.03	0.03	−1.00	0.32	−0.09	0.03
Ownership structure	0.02	0.08	0.21	0.83	−0.14	0.17
Environmental performance	0.08	0.05	1.72	0.09	−0.01	0.17
Dummy variable 1	−0.23	0.13	−1.81	0.08	−0.49	0.03
Dummy variable 2	−0.09	0.14	−0.59	0.56	−0.37	0.20
Dummy variable 3	0.24	0.19	1.27	0.21	−0.14	0.62
Dummy variable 4	−0.14	0.14	−1.00	0.32	−0.43	0.14
Dummy variable 5	−0.15	0.20	−0.77	0.45	−0.54	0.24
Dummy variable 6	−0.46	0.16	−2.87	0.00	−0.78	−0.14
Dummy variable 7	−0.17	0.16	−1.03	0.30	−0.49	0.16
Dummy variable 8	−0.22	0.20	−1.06	0.29	−0.62	0.19
Outcome: middle-level managers' engagement in OCBE						
Constant	1.68	0.34	4.94	0.00	1.01	2.35
Collective environmental identification	0.52	0.07	7.47	0.00	0.38	0.65
CEO environmentally responsible leadership	0.09	0.06	1.62	0.11	−0.02	0.20
Firm age (log)	−0.07	0.04	−1.83	0.07	−0.14	0.01
Firm size (log)	−0.02	0.02	−1.00	0.32	−0.06	0.02
Ownership structure	0.08	0.06	1.48	0.14	−0.03	0.20
Environmental performance	0.02	0.03	0.44	0.66	−0.05	0.08
Dummy variable 1	−0.15	0.10	−1.62	0.11	−0.34	0.03
Dummy variable 2	−0.11	0.11	−1.00	0.32	−0.31	0.10
Dummy variable 3	−0.08	0.14	−0.56	0.58	−0.36	0.20
Dummy variable 4	−0.10	0.11	−0.94	0.35	−0.31	0.11
Dummy variable 5	−0.12	0.14	−0.83	0.41	−0.40	0.16
Dummy variable 6	−0.18	0.12	−1.50	0.14	−0.42	0.06
Dummy variable 7	−0.42	0.12	−3.52	0.00	−0.66	−0.18
Dummy variable 8	−0.14	0.15	−0.97	0.33	−0.44	0.15
Outcome: engagement in environmental innovation						
Constant	2.11	0.86	2.46	0.02	0.41	3.81
Collective environmental identification	−0.09	0.19	−0.46	0.65	−0.47	0.30
Middle-level managers' engagement in OCBE	0.58	0.22	2.66	0.01	0.15	1.01
CEO environmentally responsible leadership	0.01	0.13	0.08	0.94	−0.25	0.27
Firm age (log)	0.01	0.08	0.07	0.95	−0.16	0.17
Firm size (log)	−0.04	0.05	−0.85	0.40	−0.14	0.06
Ownership structure	−0.08	0.13	−0.59	0.55	−0.34	0.18
Environmental performance	0.09	0.08	1.11	0.27	−0.07	0.24
Dummy variable 1	0.18	0.22	0.84	0.40	−0.25	0.62
Dummy variable 2	0.03	0.24	0.11	0.92	−0.45	0.51
Dummy variable 3	0.34	0.32	1.05	0.29	−0.30	0.97
Dummy variable 4	−0.03	0.24	−0.13	0.90	−0.51	0.45
Dummy variable 5	0.05	0.33	0.15	0.88	−0.60	0.70
Dummy variable 6	0.07	0.28	0.25	0.80	−0.48	0.62
Dummy variable 7	−0.33	0.29	−1.15	0.25	−0.90	0.24
Dummy variable 8	−0.10	0.34	−0.29	0.77	−0.77	0.58
Indirect effect of CEO environmentally responsible leadership on engagement in environmental innovation						
		Effect	**Standard error**	**Confidence interval**		
				Lower	**Upper**	
X-> M1-> M2	0.11	0.04	0.04	0.20		
X-> M1-> M2-> Y	0.07	0.04	0.01	0.16		

Note: Unstandardized regression coefficients are reported. Bootstrap sample size = 5000. X, CEO environmentally responsible leadership, M1, Collective environmental identification, M2, Middle-level managers' engagement in OCBE, and Y, Engagement in environmental innovation.

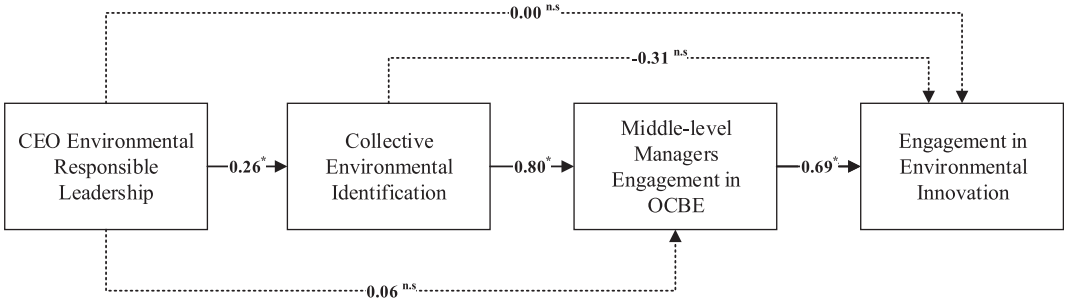

Fig. 2. Structural Equation Modeling Results without control variables. Note: N = 125. Solid lines are significant paths, and dotted lines are non-significant paths. ** $p < 0.01$; * $p < 0.05$; n.s: non-significant (two-tailed).

employees who are willing to share environmental information and practice environment-protection skills. Alternatively, they could promote frequent environment-related meetings between employees and top managers to show employees that their input into important environmental projects is appreciated and valued (Unsworth, Dmitrieva, & Adriasola, 2013). Firms could also provide employees with more information on what the organization has done to protect the environment to encourage employees to feel proud of the firm's environmental efforts. Third, our results suggest that middle-level managers' engagement in OCBE is an important part of environmental innovation. Transforming the effectiveness of environmentally responsible leadership into environmental performance requires the participation of middle-level managers, who serve as a bridge between firm strategies and anticipated outcomes. Firms that wish to advance environmental innovations should therefore consider cultivating middle managers' environmental organizational citizenship behavior. For example, CEOs could encourage middle managers to engage in helpful behaviors or create an environment in which middle managers make environment-related suggestions to the organization. In addition, CEOs could give middle-level managers the authority to implement more environment-related tasks. In this way, middle managers will translate CEOs' environmental commitment into environmental innovation outcomes.

8. Limitations and future research directions

This study has several limitations that should be considered when interpreting the findings. First, our sample consists of manufacturing firms in northeastern China, which is one of the most polluted regions in China. Our findings in this context have implications not only for this area, but also for other regions that face severe environmental problems. However, we should be careful in generalizing the findings, particularly given China's diversity and complexity and the differences between firms operating in China and other places in the world. We encourage constructive replications and extensions of our research to other regions of China and to other parts of the world.

Second, our study included only senior and middle-level managers. To obtain a more complete and accurate picture of the process by which responsible CEOs influence innovation and to capture initiatives at the micro level, future studies should include organizational members at lower levels (e.g., team leaders and production line employees). In addition, a few of the variables were self-reported, which might cause self-report bias. Although we made some efforts to minimize this potential bias, such as collecting matching data on environmental performance from third-party stakeholders, which showed a positive relationship with CEOs' subjective assessments of performance, we encourage future research to develop objective measures.

Finally, other types of leadership styles and alternative mechanisms may also have effects on environmental innovation. Due to the research purpose of this paper, we only examined the role of environmentally responsible leadership and socio-psychological mechanisms in driving environmental innovation. Given the importance of environmental innovation in the current request of sustainable development, we encourage future research to investigate how other types of leadership or other alternative mechanisms can facilitate environmental innovation, thus enriching the knowledge on how firms contribute to sustainable development.

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.

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Appendix A. Data collection procedure and measurements reference

Time	Variables	Measurements and Sources	Response Sources	Collection way
T1	Control variables	Firm age; Firm size; Ownership structure; Industry subtype	CEOs	Onsite survey
		Environmental performance (Judge & Douglas, 1998): 4-item	Local stakeholders	Onsite survey
	CEO environmentally responsible leadership	Environmental-related leadership (Robertson & Barling, 2013): 7-item	TMT members (exclude CEO)	Onsite survey
	Collective environmental identification	Environmental commitment (Raineri & Paillé, 2016): 7-item	Middle managers	Onsite survey
	Engagement in OCBE	Organizational citizenship behavior for the environment (Boiral & Paillé, 2012): 10-item	Middle managers	Onsite survey
T2 One year after T1	Environmental innovation		One of TMT members (exclude CEO)	Phone call survey

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