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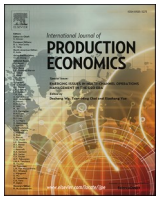

Leveraging organizational culture to create competitive value from environmental practices

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ABSTRACT

There has been a long-standing debate in the management literature as to the performance implications of environmental practices. Drawing upon the contingent resource-based view, we hypothesize that organizational culture moderates the relationship between environmental practices and firm performance. We use the competing value framework to explore the effects of developmental, group, rational, and hierarchical culture types on three key capabilities (i.e., stakeholder integration, higher-order learning, and continuous innovation) that stem from implementing environmental practices. We test our hypotheses using data from the fourth round of the High Performance Manufacturing survey. We find that the developmental, group, and rational culture types positively moderate the relationship between external proactive environmental practices and firm performance. By contrast, hierarchical culture negatively moderates the relationship between internal proactive environmental practices and firm performance, but positively moderates the relationship between external reactive environmental practices and firm performance. As such, our study contributes to the literature by unpacking the influence of organizational culture on the capabilities through which environmental practices affect firm performance. Our results can guide operations management executives in choosing the most suitable environmental practices that will align with their organizational culture.

1. Introduction

The increasing visibility of climate change impacts, such as extreme weather events and biodiversity loss, has heightened public concern about environmental issues, thus urging firms to take greater responsibility and develop more environmentally-friendly products and processes (Lui et al., 2021; Abbass et al., 2022). Firms can adopt a *reactive* strategy in environmental management, such as installing readily available pollution control technologies in their production processes or requiring suppliers to follow an environmental code of conduct (Gimenez et al., 2012; Endrikat et al., 2014). This strategy ensures firms' compliance with increasingly stringent environmental regulations and policies, thus avoiding reputational damage and consequent customer loss due to operations harming the environment. However, the need to readjust to new standards over time often incurs significant costs (Dixon-Fowler et al., 2013; Wang et al., 2018). Consequently, an increasing number of firms are adopting *proactive* environmental practices, which not only mitigate environmental impact but also offer opportunities for improving firm performance, potentially leading to a competitive advantage (Hart and Dowell, 2011; Surroca et al., 2010). For example, pollution prevention measures like waste elimination or material substitution with sustainable options can reduce production and disposal costs (Walker et al., 2008), which can result in a competitive edge over competitors. However, empirical evidence on the competitive value of *proactive* environmental practices remains mixed (Dixon-Fowler et al., 2013; Schmidt et al., 2017).

In order to better understand the effectiveness of environmental practices, the research focus has shifted towards investigating contextual factors (e.g., Schmidt et al., 2017; Xiao et al., 2018). Growing evidence shows that the competitive value of environmental practices is influenced by a firm's internal and external contexts (Vachon and Klassen, 2008; Gualandris and Kalchschmidt, 2016). We aim to contribute to this line of inquiry by investigating the contingency effect of organizational culture (OC), which consists of the beliefs, values, and principles shared by people in an organization (Cameron and Quinn, 2011). While the importance of OC in environmental management is acknowledged, extant research primarily focuses on its role as a driver of environmental management adoption (Fernández et al., 2003; Miao

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et al., 2012; Durach and Wiengarten, 2017). Our study builds on this foundation, investigating OC's role from a culture-as-moderator perspective (Bortolotti et al., 2015; Hardcopf et al., 2021), a novel approach in environmental management. This perspective enables the investigation of how OC influences the implementation and utilization of environmental practices in an operational setting, thereby enhancing or hindering their effect on firm performance (i.e., the effectiveness of environmental practices). The culture-as-moderator perspective aligns with the demonstrated impact in areas such as quality management and innovation within operational settings (Prajogo and McDermott, 2011; Marshall et al., 2016). Similar to these practices, the implementation of environmental management requires employee involvement (Hart, 1995). Prior studies have shown that OC significantly influences the extent of employee involvement and their contribution to operational improvements, thus affecting firm performance (Angell and Klassen, 1999; Fernández et al., 2003). Therefore, we argue that the influence of OC extends beyond its role as driver of environmental management adoption, as it can act as moderator by shaping how a firm and its employees perceive, interpret, and implement environmental practices, ultimately influencing firm performance (Linnenluecke and Griffiths, 2010). Therefore, we pose the research question: *How does OC influence the effectiveness of environmental practices?*

Studies on the competitive advantage of environmental practices have mostly followed the natural resource-based view (RBV) of the firm (Barney, 1991; Hart, 1995). The natural RBV posits that *proactive* environmental practices can facilitate the development of competitively valuable organizational capabilities such as *stakeholder integration*, *higher-order learning*, and *continuous innovation*, whereas *reactive* environmental practices do not have such potentials (Sharma and Vredenburg, 1998). An important extension of the RBV has been the contingent RBV, which contends that contextual factors can influence the development of capabilities from *proactive* environmental practices, and their impact on firm performance (Brush and Artz, 1999; Aragon-Correa and Sharma, 2003). Drawing upon the contingent RBV, we argue that certain cultural traits can either facilitate or hinder the development of capabilities that might emerge when firms implement *proactive* environmental practices. We therefore hypothesize that OC influences the effectiveness of *proactive* environmental practices in terms of firm performance. Furthermore, we are inspired by the theoretical proposition advanced by Gualandris et al. (2015) that *reactive* environmental practices can be a source of competitive advantage. Gualandris et al. (2015) called for further investigation of the contextual conditions that can provide greater benefits from *reactive* environmental practices. To answer this call, we challenge the natural and contingency RBVs' assumption – mostly taken-for-granted and largely unquestioned in the sustainability literature – that *reactive* environmental practices do not lead to a competitive advantage. We also explore OC's influence on the effectiveness of *reactive* practices.

In order to answer our research question, and to conceptualize OC, we have applied the competing value framework (CVF) (Cameron and Quinn, 2011) which distinguishes four culture types: group, developmental, rational, and hierarchical. We test our hypotheses using data from the fourth round of the High Performance Manufacturing (HPM) survey, which collected data from 330 manufacturing plants worldwide from three industries. We find, as predicted by the contingency RBV, support for the moderating effect of OC on the relationship between proactive environmental practices and firm performance. However, contrary to what the natural and contingency RBVs predict, we find that, in a hierarchical culture, reactive environmental practices can lead to a competitive advantage.

Our study contributes to the literature on environmental management by providing evidence for the relevance of OC as a major factor influencing the effectiveness of environmental practices. We provide detailed and nuanced insights into the moderating effects of various culture types on the effectiveness of different bundles of environmental practices. This evidence adds to previous studies investigating OC as an antecedent of environmental practice implementation. Supporting the contingent RBV perspective, we find that proactive environmental practices are not always able to develop key organizational capabilities, but that competitively valuable capabilities do emerge when *proactive* environmental practices are implemented under favorable cultural conditions. Furthermore, we challenge the widely shared assumption that *reactive* environmental practices do not lead to a competitive advantage and propose a new capability, *compliance* capability, that can be developed from *reactive* environmental practices under hierarchical culture. These findings can guide managers when making investment decisions related to environmental management in order to maximize firm performance based on their firm's OC.

2. Literature review and theoretical foundation

2.1. A contingent resource-based view of proactive environmental practices

The resource-based view (RBV) of the firm (Barney, 1991) has been widely applied to understand and explain the performance implications of environmental practices (e.g., Yang et al., 2019). Notwithstanding the dominance of the RBV in explaining varying effectiveness of environmental practices, it has been faced with serious critics: "the moment we try to explain or predict the firm's actual performance […] the RBV turns out to be incomplete because it ignores the material contingencies of the firm's situation." (Kraaijenbrink et al., 2010, p. 365). As such, scholars such as Sharma and Vredenburg (1998) and Aragon-Correa and Sharma (2003) combined the contingency theory with the RBV to propose a contingent RBV to address this "context insensitivity" of the RBV. The contingent RBV argues that contextual factors may influence the development of valuable capabilities from *proactive* (rather than *reactive*) environmental practices and, in turn, their effect on performance. To date, those sustainability researchers that have applied the contingent RBV to explore external contingency factors such as information asymmetries (Brush and Artz, 1999), uncertainty, complexity, and munificence of the competitive environment (Aragon-Correa and Sharma, 2003), and a firm's supply chain position (Schmidt et al., 2017). We join this stream of literature to investigate the contingency effect of OC, which has proven to be a highly important factor influencing the implementation of management practices and their effectiveness (Marshall et al., 2016).

The contingent RBV highlights three key capabilities that can be developed by *proactive* environmental practices: the capabilities of *stakeholder integration*, of *higher-order learning*, and of *continuous innovation* (Sharma and Vredenburg, 1998; Yang et al., 2019). Stakeholder integration capability is the "ability to establish trust-based collaborative relationships with a wider variety of stakeholders" (Sharma and Vredenburg, 1998, p. 735). It consists of the abilities to communicate with stakeholders in the environmental domain, to collaborate with them to find solutions to environmental problems, and to steer new developments through effective public consultation processes. Firms implementing proactive environmental practices tend to engage stakeholders in order to tackle environmental issues. Such a tendency can facilitate public consultation processes since stakeholders are more likely to raise concerns and provide suggestions. As such, firms can develop cost-effective and environment-friendly products and processes (Sharma and Vredenburg, 1998). Improved stakeholder relationships can help generate competitively valuable intangible resources which are not directly available in the market (Surroca et al., 2010). For example, favorable responses from internal stakeholders, such as employees and managers, can benefit the firms in terms of improved employee commitment, stability, innovation, and reduced internal transaction costs. Similarly, favorable responses from external stakeholders can benefit the firms in terms of improved reputation, customer loyalty, and reduced external transaction costs (Jones et al., 2018; Surroca et al., 2010).

Higher-order learning capability refers to "the development of different interpretations of new and existing information, as a result of developing new understanding of surrounding events" (Sharma and Vredenburg, 1998: p. 740). This capability includes line-staff cooperation and integration around environmental information exchange, continuous expansion of knowledge concerning the business – natural environment interface, and the ability to look from fresh angles for solutions to environmental problems (Yang et al., 2019). Effective solutions to environmental issues are rarely available in the market and often need to be developed by the firm in order to overcome organizational and technological constraints. Firms taking a reactive stance are very likely to stop short of purchasing readily available technologies for pollution control, and such actions do not trigger any substantial product improvement and process re-design (Russo and Fouts, 1997). In contrast, firms taking a proactive stance tend to go beyond the low-hanging fruits and adopt more drastic measures, initiating fundamental changes and thinking outside the box (Yang et al., 2019). As such, proactive environmental practices can broaden the scope of knowledge acquisition and creation at the business – natural environment interface, thereby improving firm-level learning capabilities (Russo and Fouts, 1997; Sharma and Vredenburg, 1998).

Continuous innovation capability, or continuous improvement capability (Hart, 1995), is indicative of "a changing experiential base of organizational activities, routines, and goals" (Sharma and Vredenburg, 1998: p. 741). It encompasses the abilities to identify opportunities to experiment, to carry out continuous improvement, and to achieve improved operations while reducing environmental impact (ibid). Firms that have implemented proactive environmental practices are able to use existing knowledge to bring about concrete changes in terms of products and processes that have reduced environmental impact. Proactivity in improving production activities and products ahead of competitors is likely to give firms an advantage over main competitors (Surroca et al., 2010; Wiklund, 1999).

2.2. Organizational culture (OC)

OC is defined as the set of beliefs and values that are shared by members of an organization; it is the "social or normative glue that holds an organization together" (Smircich, 1983, p. 344). Culture provides a sense of identity and a shared understanding of "what matters most" to organizational members in everyday issues, and may guide their behaviors (Cameron and Quinn, 2011). As such, OC has proven to be a highly important factor influencing the implementation of management practices and their effectiveness (Marshall et al., 2016).

As a multi-dimensional concept (Schneider et al., 2013), OC in our study is assessed using the CVF (Cameron and Quinn, 2011), a well-recognized theoretical model in OC research (Hartnell et al., 2011; Schneider et al., 2013). The CVF (illustrated in Fig. 1) is built upon two axes representing deferring value orientations: control vs. flexibility, and internal vs. external focus (Denison and Spreitzer, 1991). By combining these two axes, four culture types are distinguished: developmental, group, rational, and hierarchical cultures (Denison and Spreitzer, 1991). While every firm may have unique cultural traits, these represent four fundamental types that are comparable across organizations (Hartnell et al., 2011; Schneider et al., 2013). When a culture type aligns with management practices, it can facilitate their adoption or enhance their effectiveness, while culture-practice misfit can hinder practice adoption or effectiveness (Kull and Wacker, 2010; Bortolotti et al., 2015).

In the sustainability literature, there has recently been a growing interest in the culture–sustainability relationship, with most studies examining OC as a driver of sustainability practices (e.g., Durach and Wiengarten, 2017; Lee and Kim, 2017; Pagell et al., 2014). Our study, however, adopts a *culture-as-moderator perspective* (Bortolotti et al., 2015; Hardcopf et al., 2021). While this perspective has not been investigated for environmental management, it can explain the effectiveness of other similar practices implemented in an operational setting (Marshall et al., 2016). For instance, as with environmental management, the effectiveness of quality management depends on employee involvement and participation in operational processes improvement. Cultural traits such as group/collectivism and a low hierarchy have been shown to promote collaboration and employee participation in decision-making processes, which are crucial for effective continuous improvement (Naor et al., 2008). Therefore, it can be expected that OC can similarly affect their effectiveness of environmental practices.

3. Research framework and hypothesis development

This section introduces the research framework and the development of our hypotheses, which propose relationships between environmental practices and firm performance, moderated by OC.

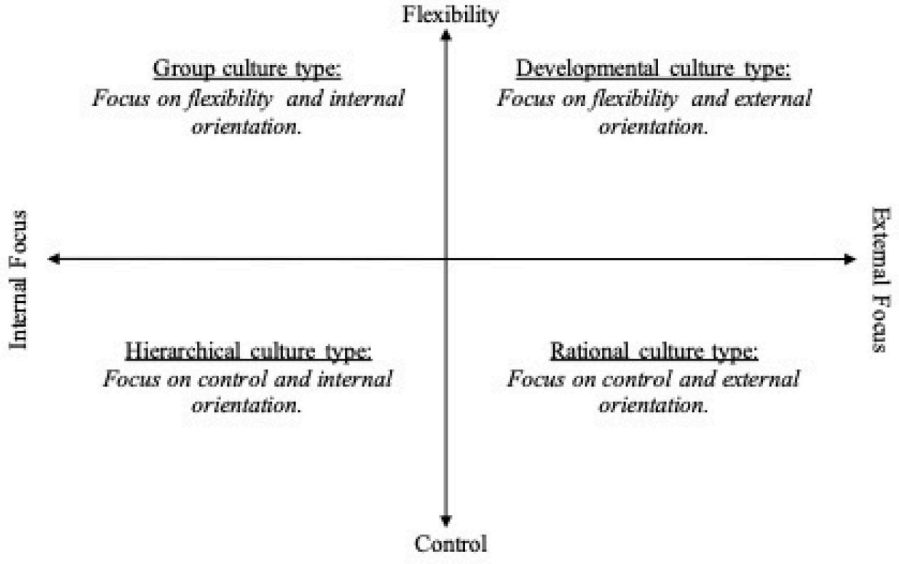

Fig. 1. The competing values framework.
Adapted from Denison and Spreitzer (1991).

3.1. Research framework

Drawing on the contingent RBV and the research idea of examining the contingency effect of OC, we develop and empirically test a research framework (Fig. 2). The research framework depicts the influence of *proactive* and *reactive* environmental practices on firm performance (hypotheses H1 and H2 – Section 3.2), and the impact of OC on the effectiveness of proactive environmental practices (hypotheses H3a, b, c, d – Section 3.3). In order to develop a detailed and comprehensive understanding of the cultural traits that support environmental practices, we investigate how each of the four cultures in the CVF affects the competitive values of environmental practices. The contingent RBV posits that a contextual variable will positively (or negatively) influence the effectiveness of the proactive environmental practices when it fosters (or hinders) the development of one or more linked valuable competitive capabilities (i.e., developing stakeholder integration, higher-order learning, or continuous innovation capabilities). If environmental practices do not develop valuable competitive capabilities, the contingent RBV predicts that contextual variables will not influence practice effectiveness. According to the contingent RBV, this is the case of *reactive* environmental practices. On this basis, we decided against formulating moderating hypotheses on the effectiveness of *reactive* environmental practices. However, inspired by the anecdotal evidence found by Gualandris et al.'s (2015) in support of a competitive advantage derived from *reactive* environmental practices, we included exploratory analyses of the interaction effects between OC and *reactive* environmental practices on firm performance (as represented by the dashed line arrow in Fig. 2).

3.2. The impact of environmental practices on firm performance

Proactive environmental practices reflect a firm's voluntary efforts to balance business priorities and environmental objectives (Aragon-Correa and Sharma, 2003), and such practices are mostly based on continuous learning and the application of new knowledge (Hart, 1995; Sharma and Vredenburg, 1998). Typical *proactive* environmental practices include internal and external practices such as waste reduction in internal processes, pollution prevention, and co-development with key suppliers to reduce the environmental impact of supply chain processes (Dixon-Fowler et al., 2013; Gimenez et al., 2012). Specifically, internal proactive environmental practices refer to actions and initiatives taken by firms to minimize their own environmental impact in terms of resource consumption, energy consumption, waste emission, and others (Aragon-Correa and Sharma, 2003). Practices in this category include waste reduction programs, pollution prevention, and environmental management systems. By contrast, external proactive environmental practices refer to actions and initiatives that firms take beyond their own operations to reduce the environmental impact of their supply chain activities (Aragon-Correa and Sharma, 2003). Practices in this category include supplier monitoring & development, sustainable purchasing, and supply chain sustainability collaboration. Following the contingent RBV (Aragon-Correa and Sharma, 2003), we argue that substantial implementation of such *proactive* environmental practices will likely contribute to the firm's development of three competitively valuable capabilities, namely the capabilities of *stakeholder integration*, *higher-order learning*, and *continuous innovation*. The development of these capabilities can benefit the firm's performance in multiple ways, because such capabilities are rare and difficult to obtain from the market. Sharma and Vredenburg (1998) provided the first systematic empirical evidences showing that these capabilities, resulting from implementing *proactive* environmental strategies, accounted for more than 50% of the variances in the firms' self-reported competitive advantage, reflected in product/process/operational innovations, cost reductions, and other benefits. Several recent studies (e.g., Yang et al., 2019; Zhuang et al., 2021) provide further empirical evidences on the competitive values of *proactive* environmental practices and the resulted organizational capabilities. Based on these observations, we formulate the following first hypothesis.

H1. Proactive environmental practices, including internal and external practices, have a positive impact on firm performance.

The second type of environmental practices that firms can implement is *reactive* environmental practices. These practices reflect a firm's focus on complying with environmental regulations, where environmental management is not regarded as an opportunity for increasing competitiveness, but rather as an additional operational constraint (Aragón-Correa and Sharma, 2003). Internal reactive environmental practices are taken by firms in response to environmental issues or challenges that arise in their own operations, including regulatory compliance programs and end-of-pipe treatment of water/air emissions. By contrast, external reactive environmental practices are more often taken in response to issues or challenges outside of the firms' operations,

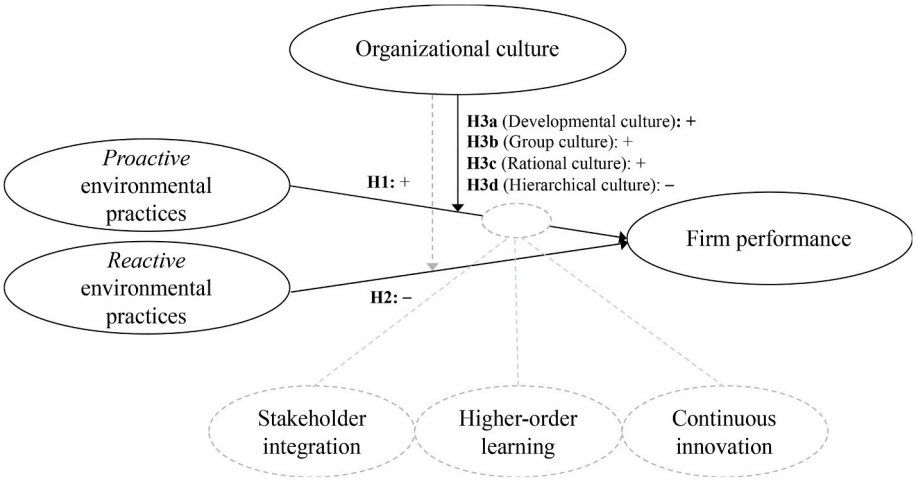

Fig. 2. Research framework
Notes:
The dashed line arrow represents a non-hypothesized relationship
- Dashed ovals represent non-measured variables (i.e., the valuable competitive capabilities)
- Dashed lines indicate the position in the framework (i.e., the empty oval) where the contingency RBV predicts the development of valuable competitive capabilities occurs.

including extending environmental standards along supply chains and incorporating environmental considerations in selecting and evaluating suppliers (Sharma and Vredenburg, 1998; Aragon-Correa and Sharma, 2003). Sharma and Vredenburg (1998) conclude that valuable competitive organizational capabilities can only be developed from *proactive* environmental practices, and that *reactive* environmental practices, such as investing in pollution control technologies that are available in the market, do not add to a firm's knowledge and ability to change (Endrikat et al., 2014), and will not lead to the development of valuable competitive organizational capabilities. Past research (e.g., Gimenez et al., 2012; Vachon and Klassen, 2008) has indeed found that *reactive* practices involving suppliers do not lead to learning. Since investments in *reactive* environmental practices may not lead to the development of valuable competitive organizational capabilities (Endrikat et al., 2014; Kim, 2018), the costs of adopting such practices may very likely outweigh the potentially limited returns. This leads to our second hypothesis.

H2. Reactive environmental practices, including internal and external practices, have a negative impact on firm performance.

3.3. OC and its impact on practice effectiveness

A developmental culture emphasizes preparation for, and anticipation of, the future (Cameron and Quinn, 2011). Firms characterized by a developmental culture focus on flexibility and have an external orientation (Denison and Spreitzer, 1991), their employees have a long-term orientation and their leaders are visionary and entrepreneurial (Cameron and Quinn, 2011). In implementing *proactive* environmental practices, a developmental culture may facilitate the development of a *stakeholder integration* capability. Due to their external focus and long-term orientation, such firms tend to have extensive records of engaging with various stakeholders in product and process improvements (Cameron and Quinn, 2011). Such experiences allow firms to better understand stakeholders' concerns, interests, and preferences that they can use to guide improvements in order to pioneer industry trends (Cameron and Quinn, 2011). Cao et al. (2015) found that a development culture is positively related to developing strategic collaboration with stakeholders along supply chains. Such firms will have a proactive approach to reaching out to a wide range of stakeholders when tackling specific environmental issues (Durach and Wiengarten, 2017).

A developmental culture can also facilitate the development of *higher-order learning* capabilities when implementing *proactive* environmental practices. Such firms tend to encourage employees to be creative and take bold initiatives such as suggesting radical improvements (Prajogo and McDermott, 2011). Risk-taking and experimentation can lead to long-term benefits, and these approaches are supported by flexible organizational structures (Cameron and Quinn, 2011). Cao et al. (2015) found that a developmental culture also encourages cross-functional collaborations within a firm. Similarly, we would expect employees to feel encouraged to creatively incorporate stakeholders' feedback in their improvement suggestions for tackling environmental problems. In such an environment, employees will be encouraged to think outside the box to identify more radical environmental solutions, thus fostering the ability to acquire and apply new knowledge in developing innovative solutions. Overall, because a developmental culture is likely to facilitate the development, from implementing *proactive* environmental practices, of *stakeholder integration* and *higher-order learning* capabilities, we hypothesize.

H3a. A developmental culture positively moderates the relationship between proactive environmental practices and firm performance.

Group culture's primary focus is on the internal organization and flexibility, emphasizing cohesion and morale among employees (Denison and Spreitzer, 1991), who then tend to feel more part of an extended family rather than of an economic entity (Cameron and Quinn, 2011). Group culture facilitates the development of *higher-order learning* capabilities from the implementation of *proactive* environmental practices. With their internal orientation towards benefitting organizational members, such firms tend to promote a non-punitive organizational environment where employees are encouraged to share their concerns and ideas for improvements (Cameron and Quinn, 2011). This is relevant since empowerment and trust have been found to be crucial for innovation and experimentation (e.g., Prajogo and McDermott, 2011). Moreover, a group culture encourages structural flexibility, which is crucial for knowledge sharing and communication across functions (Cao et al., 2015). As such, a non-punitive organizational environment and cross-functional collaborations will be supportive of knowledge sharing on environmental issues, which in turn can result in continually expanding knowledge for developing innovative environmental solutions (Hart, 1995; Sharma and Vredenburg, 1998).

When implementing proactive environmental practices, a group culture can also facilitate the development of a *continuous innovation* capability. Given the effective communication and cooperation, firms with such a culture are quick in developing shared understandings across functions and among employees (Naor et al., 2008). Once a consensus has been reached about the causes of a certain problem, and ideas for improvement have been generated, firms will quickly translate these ideas into solutions (Cameron and Quinn, 2011). We would expect a similar systematic approach to tackling problems and implementing solutions to occur in environmental management. Overall, because a group culture is likely to facilitate the development of *higher-order learning* and *continuous innovation* capabilities from implementing *proactive* environmental practices, we hypothesize that.

H3b. Group culture positively moderates the relationship between proactive environmental practices and firm performance.

Rational culture is oriented towards the external market and emphasizes engagement with external stakeholders to improve corporate competitiveness (Denison and Spreitzer, 1991). It values control and emphasizes performance and the achievement of measurable goals (Cameron and Quinn, 2011). Firms characterized by a rational culture aim to increase their market share and be recognized as market leaders (Cameron and Quinn, 2011). A rational culture can facilitate the development of a *stakeholder integration* capability when implementing *proactive* environmental practices. Given their orientation towards the external market, firms tend to extensively engage with external stakeholders (Cameron and Quinn, 2011) in order to understand their concerns and preferences, and then use such information to determine their own goals and actions (Naor et al., 2008). Since *proactive* environmental practices can be more successful when a wide range of stakeholders are engaged (Buysse and Verbeke, 2003; Yang et al., 2019), this is facilitated by a rational culture, through which managers and employees are able to engage with a wide range of stakeholders in identifying environmental solutions.

Rational culture can also facilitate the development of a *continuous innovation* capability when implementing *proactive* environmental practices. By levering control and being strongly focused on goal achievement, firms are likely to quickly translate improvement ideas into effective solutions for creating a competitive advantage (Cameron and Quinn, 2011). Similarly, we would expect an external focus, combined with an orientation towards goal fulfillment, to facilitate the ability of a firm to improve processes and products from an environmental perspective. Firms characterized by a rational culture are expected to make such improvements on a regular basis, through instigating feasible solutions, and in anticipation of regulations and competitors. Overall, because a rational culture is likely to support the development of *stakeholder integration* and *continuous innovation* capabilities from *proactive* environmental practices, we posit that.

H3c. Rational culture positively moderates the relationship between proactive environmental practices and firm performance.

A firm with hierarchical culture has an internal focus and emphasizes efficiency, uniformity, and coordination (Denison and Spreitzer, 1991). Leaders seek to maintain control over the organization. They organize the daily activities of their subordinates and monitor processes that are predictable and efficient (Cameron and Quinn, 2011). When implementing *proactive* environmental practices, a hierarchical culture can hinder the development of *higher-order learning* since this capability requires employees to think outside the box and to initiate fundamental changes (Sharma and Vredenburg, 1998; Yang et al., 2019), whereas a hierarchical culture tends to limit creativity in favor of stability and predictability. Hierarchical cultures stress the importance of rules and procedures to govern activities, leaving employees little discretion in their jobs (Cameron and Quinn, 2011). We would expect a focus on stability and uniformity to hinder knowledge sharing and experimentation in redesigning products and processes for a reduced environmental impact. Since a hierarchical culture is likely to hinder the development of *higher-order* learning capabilities from *proactive* environmental practices, we hypothesize that.

H3d. Hierarchical culture negatively moderates the relationship between proactive environmental practices and firm performance.

4. Methodology

4.1. Sample and data collection

To test our hypotheses, we used data from the fourth round of the High Performance Manufacturing (HPM) research project (for a general description of the HPM project, see also Schroeder and Flynn, 2002). Between 2013 and 2018, an international group of researchers collected data from 330 manufacturing plants, randomly selected from a master list of manufacturing plants. The selected plants are a mix of high-performing and traditional plants, operating in either the transportation equipment, machinery, or electronics sectors. These plants are located across 15 countries and regions: Brazil, China, Finland, Germany, Israel, Italy, Japan, Spain, South Korea, Sweden, Switzerland, Taiwan, United Kingdom, United States of America, and Vietnam. Each selected plant operates independently, not being part of a common corporation, and maintains a workforce of at least 100 employees. Table 1 reports the sample distribution divided by country/region and sector.

The data were collected in a similar way in all the countries/regions through the application of shared guidelines. In each country, a team of researchers was in charge of contacting the selected plants, administrating the questionnaires, and providing assistance to respondents to ensure that the information gathered was correct and complete. All the plants received a set of 12 different questionnaires, translated as necessary, one for each functional area. Each questionnaire was designed with a variety of item types. This included both objective data and perceptual scales. Some scales were also reversed. Table 2 reports the subjects covered in each questionnaire and provides examples of respondent titles for each targeted functional area. The response rate was about 65%, indicating that the non-response bias should not be a concern for the present study (Flynn et al., 1990). Although widely used in OM, survey research has received criticism, especially in relation to concerns over common method bias (Ketokivi and Schroeder, 2004; Flynn et al., 2018). Conscious survey design interventions have been proposed to minimize the impact of this issue (Podsakoff et al., 2003). These proposed survey design interventions were followed. Reliable, tested measurement items and scales from the literature were used wherever possible. As having a single respondent is considered to potentially be a significant source of systematic measurement errors (Podsakoff et al., 2003), each questionnaire was answered by two respondents (excluding the accounting one, as it includes objective questions only and, therefore, is not subject of measurement errors). The most knowledgeable respondents were selected for each questionnaire (Table 2), and were asked to answer the questions as honestly as possible with their anonymity being assured. We checked the inter-rater agreement and verified that all interclass correlation (ICC) indexes were above the acceptance threshold of 0.7. The items used to measure the dependent and independent variables of this study were contained in different questionnaires. Specifically, the plant management questionnaire contained the items used to measure firm performance. The environmental affairs questionnaire held those for environmental practices, while the items for assessing OC were included in the human resource management, process engineering, supervision, and plant management questionnaires. Although these conscious efforts may not have eliminated common method bias altogether, it should have kept it within acceptable limits (Flynn et al., 2018).

4.2. Measures

The meta-analytical review by Golicic and Smith (2013) clearly showed that OM scholars used various classifications of environmental practices. We used one of the common approaches to differentiate *proactive* practices from *reactive* practices (Dixon-Fowler et al., 2013) since this fits with the aim of our study. In addition, we distinguished between *internally*-related practices and *externally*-related practices involving suppliers, an approach followed in several studies in the SCM literature (e.g., Shah and Ward, 2007) and that on sustainability (e.g., Gimenez et al., 2012). We therefore operationalized environmental practices using four multi-item scales: *internal proactive, internal reactive, external*

Table 1
Sample distribution by country/region and sector.

Country/region (Total)	Sectors		
	Transportation	Machinery	Electronics
Brazil (24)	12	7	5
China (30)	4	16	10
Spain (25)	10	7	8
Finland (17)	5	6	6
Germany (28)	9	13	6
Israel (26)	0	5	21
Italy (29)	5	17	7
Japan (22)	9	7	6
South Korea (26)	13	5	8
Sweden (9)	1	4	4
Taiwan (30)	1	10	19
United Kingdom (13)	4	5	4
United States (15)	3	7	5
Vietnam (25)	8	7	10
Switzerland (11)	2	6	3
Total (330)	86	122	122

Table 2
Subjects of the questionnaires and examples of functional area respondent titles.

Questionnaire	Functional Area Respondents
Accounting	Accounting manager
Downstream Supply Chain	Demand/Sales manager, Logistics manager
Environmental Affairs	Director of environmental affairs, Sustainability manager
Human Resource	Director of human resources, Human resource manager
Information Technology	Chief information officer, Information technology manager
Plant Management	Chief operating officer, Plant manager
Process Engineering	Industrial engineer, Process/Production engineer
Product Development	Product development manager, Product designer/engineer
Production Control	Inventory manager, Production control manager
Quality	Quality manager, Quality engineer
Supervision	Department leader, Supervisor
Upstream Supply Chain	Procurement/Purchasing manager, Transportation manager

proactive, and *external reactive practices* (Appendix A). In more detail, the scale of *internal proactive* environmental practices captures aspects of waste reduction, pollution prevention, avoiding environmental accidents, and environmental improvements (Roy et al., 2020). The *internal reactive* environmental practices scale captures compliance with environmental standards specified by customers, industry associations, and other stakeholders (Picasso et al., 2023). The scale of *external proactive* environmental practices captures a firm's efforts to collaborate with major suppliers in seeking environmental innovations, new product development, and environmental improvements (Danese et al., 2019). The *external reactive* environmental practices scale captures a firm's efforts to integrate environmental standards in supplier selection and evaluation (Kähkönen et al., 2018). Together, the items in these four scales capture the extent to which a plant is engaged in environmental practices. They were operationalized as Likert-scale items, with values ranging from 1 ("no extent whatsoever") to 5 ("very great extent").

Studies investigating the payoffs from environmental practices use various measures to operationalize firm performance (Dixon-Fowler et al., 2013). We operationalized firm performance as operational performance, using four items: unit cost of manufacturing, conformance to product specifications (i.e., quality), on-time delivery, and flexibility in changing volumes (Naor et al., 2010). We followed the approach of previous OM scholars in using a formative multi-item scale of operational performance (e.g., Naor et al., 2010; Vachon and Klassen, 2008) rather than financial indicators, as the latter can be indirectly influenced by operational practices. We used self-reported perceptual measures of performance, relative to competitors, following a commonly accepted approach seen in other surveys (Ketokivi and Schroeder, 2004). The items in the scale capture a plant's performance relative to competitors and were again operationalized as Likert-scale items, this time with values ranging from 1 ("much worse") to 5 ("much better").

We used the scales developed by Naor et al. (2008), and recently tested by Hardcopf et al. (2021), to operationalize the four culture types (developmental, group, rational, and hierarchical) in the CVF (Appendix B). The scale for developmental culture captures the extent to which the firm has a long-term orientation and takes proactive actions to embrace novel technologies. The group culture scale captures the team atmosphere and manager-worker relationships within a firm. The scale for rational culture captures a firm's goal-oriented incentive system. Finally, the hierarchical culture scale captures the extent of managerial control within a firm. Overall, the items in these four scales captured our respondents' assessments of various aspects of culture. Again, these were measured using Likert-scale items, with values ranging from 1 ("strongly disagree") to 5 ("strongly agree").

Following previous studies linking environmental practices and firm performance (e.g., Golicic and Smith, 2013), we controlled for industry and for firm size to control for resources available to the firm. We included dummy variables for the industry, and we measured plant size as the natural logarithm of the number of employees in a firm (Kull and Wacker, 2010).

4.3. Measure assessment

As a preliminary step in assessing the quality of our measurements, we assessed the normality of each scale item. All measures satisfied the normality tests, with skewness values below 1.21 and kurtosis absolute values above 2.56 (Muthén and Kaplan, 1985). We then conducted a confirmatory factor analysis (CFA) to assess the quality of the measurement in terms of convergent validity, discriminant validity, and reliability. The CFA test for convergent validity showed that our structure of items for measuring the four types of environmental practices and the four culture types produced a well-fitting model ($\chi 2 = 447.02$, $\chi 2/\text{d.f.} = 1.65$, RMSEA = 0.047, and CFI = 0.954). Further, as shown in Appendices A and B, all the items had acceptable loadings (i.e., above the threshold of 0.70), suggesting convergent validity. We used the CFA to evaluate the χ^2 differences between the constrained and unconstrained models for each pair of constructs. All the χ^2 differences were statistically significant, indicating discriminant validity. Further, we checked that all the composite reliability values were indeed above 0.70 (see Appendices A and B). These results provide evidence for the convergent validity, discriminant validity, and reliability of our constructs.

5. Results

We conducted multiple regression analysis for hypothesis testing (Hayes, 2013). The main results for hypothesis testing are reported and discussed in Section 5.1. Given our interest in investigating the moderating effects on performance (H3a-d), we aimed to delve deeper into these relationships to better understand under which circumstances the effects of environmental practices on performance are significant or non-significant. Drawing upon proven approaches (e.g., Salvador and Villena, 2013; Lu and Shang, 2017), we adopted the Johnson-Neyman technique to construct confidence band plots. This technique has a significant advantage over traditional interaction plots as it offers valuable insights into the region of significance (Lu and Shang, 2017). It permits to visually map the interplay between environmental practices and OC dimensions in terms of performance effects. It provides a means to show when the effects become significant, referred to as the "regions of significance". This in turn illuminates the relative sensitivity of firm performance to the interactions under study (Tenhiälä and Helkiö, 2015). In doing so, we are not only able to test our hypotheses, but also meaningfully interpret the results and present their practical implications. The confidence band plots are presented and discussed in Section 5.2.

Table 3
Regression analysis results.

Variables	Model				
	Firm Performance				
Hypothesis	H1 H2	H3a	H3b	H3c	H3d
Firm size (log)	−0.098	−0.091	−0.094	−0.104	0.096
Industry 1 (Machinery)	0.105	0.102	0.103	0.098	0.089
Industry 2 (Electronics)	−0.018	−0.037	−0.043	−0.026	0.022
Proactive Internal (PI)	0.073	0.057	0.067	0.056	0.090
Proactive External (PE)	0.070	0.058	0.084	0.079	0.049
Reactive Internal (RI)	−0.106	−0.096	−0.126	−0.090	−0.125
Reactive External (RE)	0.101	0.105	0.096	0.091	0.119
Developmental Culture (DEV)	0.059	0.059	0.049	0.058	0.063
Group Culture (GRO)	0.447[b]	0.439[b]	0.463[b]	0.428[b]	0.450[b]
Rational Culture (RAT)	0.130[a]	0.139[b]	0.120[a]	0.144[b]	0.114[a]
Hierarchical Culture (HIE)	0.136[b]	0.133[a]	0.141[b]	0.126[a]	0.126[a]
PI x DEV		−0.055			
PE x DEV		0.161[a]			
RI x DEV		−0.007			
RE x DEV		0.004			
PI x GRO			−0.004		
PE x GRO			0.198[b]		
RI x GRO			−0.088		
RE x GRO			0.024		
PI x RAT				0.030	
PE x RAT				0.227[b]	
RI x RAT				0.021	
RE x RAT				−0.090	
PI x HIE					−0.17[a]
PE x HIE					0.011
RI x HIE					−0.059
RE x HIE					0.189[a]
Adj. R^2	0.320	0.331	0.340	0.347	0.338

Note: Significance at.
[a] $p < .05$.
[b] $p < .01$.

5.1. Main results: hypothesis testing

The hypotheses were tested using a multiple regression analysis (Hayes, 2013), and the results from the regression analyses are shown in Table 3.

Although hypotheses were not developed on the interactions between *reactive* environmental practices and culture types, Table 3 also includes these interactions. As explained in the introduction, we included exploratory analyses of *reactive* environmental practices based on the finding of Gualandris et al.'s (2015) study. Dissenting from most of the research on sustainability, they provided anecdotal evidence to support there being a competitive advantage from *external reactive* practices linked to supplier monitoring, and called for further investigation into the contextual conditions that can enhance these benefits.

In contrast to what we had hypothesized (H1), Table 3 indicates that none of the environmental practices have a significant effect on firm performance. In partial support of H3a, we found that developmental culture positively moderates the relationship between *proactive* environmental practices involving suppliers and firm performance ($\beta = 0.161$; $p < 0.05$). In partial support of H3b, we found that group culture positively moderates the relationship between *proactive* environmental practices involving suppliers and firm performance ($\beta = 0.198$; $p < 0.01$). In partial support of H3c, we found that rational culture positively moderates the relationship between *proactive* environmental practices with suppliers and firm performance ($\beta = 0.227$; $p < 0.01$). Finally, we found that hierarchical culture negatively moderates the relationship between *internal proactive* environmental practices and firm performance ($\beta = -0.170$; $p < 0.01$), providing partial support for H3d.

Further, our analyses find no significant effect of *reactive* environmental practices on firm performance. As such, H2 is not supported. However, we did find that hierarchical culture positively moderates the relationship between *reactive* environmental practices involving suppliers and firm performance ($\beta = 0.189$; $p < 0.05$), which indicates that such practices can contribute to firm performance in those organizations that can be characterized by a strongly hierarchical culture.

To address the risk of endogeneity from simultaneity and omitted variables, which can result in inconsistent outcomes, we applied a two-stage least squares (2SLS) regression analysis with instrumental variables (Ketokivi and McIntosh, 2017). We employed an iterative process to identify high-quality and theoretically relevant instrumental variables for each independent variable (Lu et al., 2018): personnel length of employment and investments in plant & equipment for both *internal proactive* and *internal reactive* environmental practices; formal supplier evaluation systems and supplier development support for both *external proactive* and *external reactive* environmental practices. We employed the Wu-Hausman test to ensure our instrumental variables are not correlated with the error term. All results had p-values greater than 0.05, indicating adequate exogeneity of the instrumental variables. Furthermore, we employed the Stock-Yogo test to evaluate their relevance. All first-stage F-statistics were above the suggested threshold ($F = 19.93$), highlighting the relevance of the instrumental variables. The results of the 2SLS regression analysis, reported in Table 4, are comparable to the OLS results, suggesting that endogeneity is not a serious issue.

Table 4
Endogeneity analysis results.

Dependent variable	Firm Performance			
Independent variable	Proactive Internal	Proactive External	Reactive Internal	Reactive External
OLS results	0.073 ($p >$ 0.05)	0.070 ($p >$ 0.05)	−0.106 ($p >$ 0.05)	0.101 ($p >$ 0.05)
2SLS results	0.111 ($p >$ 0.05)	0.181 ($p >$ 0.05)	−0.082 ($p >$ 0.05)	0.222 ($p >$ 0.05)
Wu-Hausman	2.66 ($p =$ 0.11)	0.328 ($p =$ 0.57)	0.96 ($p =$ 0.33)	1.09 ($p =$ 0.30)
Stock-Yogo	$F = 23.17$	$F = 20.49$	$F = 20.84$	$F = 20.41$

5.2. Additional analyses: plots for significant effects

Our regression results show some significant moderating effects of culture. Following an approach used elsewhere (e.g., Salvador and Villena, 2013; Lu and Shang, 2017), we adopted the Johnson-Neyman technique to construct confidence band plots to gain further insight into when the effect moves from one "significance zone" into another. This test shows for what ranges of a culture type can environmental practices support or hinder a competitive advantage. As Fig. 3 shows, the effect of both group and rational culture types on the relationship between *external proactive* environmental practices and firm performance moves from significantly negative, through non-significant, to significantly positive as the culture strengthens. The effect of developmental culture type on the relationship between *external proactive* environmental practices and firm performance differs in that it only moves from non-significant to significantly positive. Finally, the effect of the hierarchical culture type on this relationship moves from significantly positive to non-significant as the culture type strengthens. We discuss the implications of these findings further in the Discussion Section.

Table 3 also shows that a hierarchical culture has a significant moderating effect on the relationship between *external reactive* environmental practices and performance. As in the case of significant interactions among culture types and *proactive* practices, we constructed a confidence band plot (Fig. 4). This shows that the effect of hierarchical culture type switches from not significant to significantly positive as the culture type becomes stronger.

6. Discussion and conclusions

6.1. Competitive value from proactive environmental practices: the contingent role of OC

Our results do not provide unequivocal support for *proactive* environmental practices having a positive influence on firm performance. We have two explanations for these results. First, firm performance is not an immediate outcome of implementing *proactive* environmental practices (Sharma and Vredenburg, 1998; Zhu and Sarkis, 2004). Second, an improved environmental performance from *proactive* environmental practices could be seen as an immediate but short-term outcome (Zhu and Sarkis, 2004), and therefore one that cannot ensure a sustained long-term competitive advantage. Maintaining a competitive advantage requires the ability to develop and sustain complex intangible organizational capabilities that are difficult to acquire and take time (Hart, 1995;Hart and Dowell, 2011), which can result in improved firm performance. This finding, reflects the difficulty in gaining competitive value from the implementation of *proactive* environmental practices. The lack of a universal competitive advantage from environmental practices lends support to the core argument of the contingent RBV: that the value creation process of *proactive* environmental practices can be influenced by contextual factors (Aragon-Correa and Sharma, 2003).

Drawing upon the contingent RBV, we investigated the role of OC, as a potentially important contextual factor in terms of influencing the competitive value of *proactive* environmental practices. Our findings show the importance of taking a nuanced perspective when investigating the impact of OC on environmental practice effectiveness. That is, one should distinguish (1) among different types of OC since different culture types can influence environmental practices in different ways (e.g., Lee and Kim, 2017), rather than treating OC as one aggregate construct (Naor et al., 2008); and (2) between *internal* and *external proactive* environmental practices (Kim, 2018), as *internal* and *external proactive* practices do not have the same interaction patterns with the culture types, thus contributing differently to the creation of a competitive advantage. A plausible explanation for the differences in the

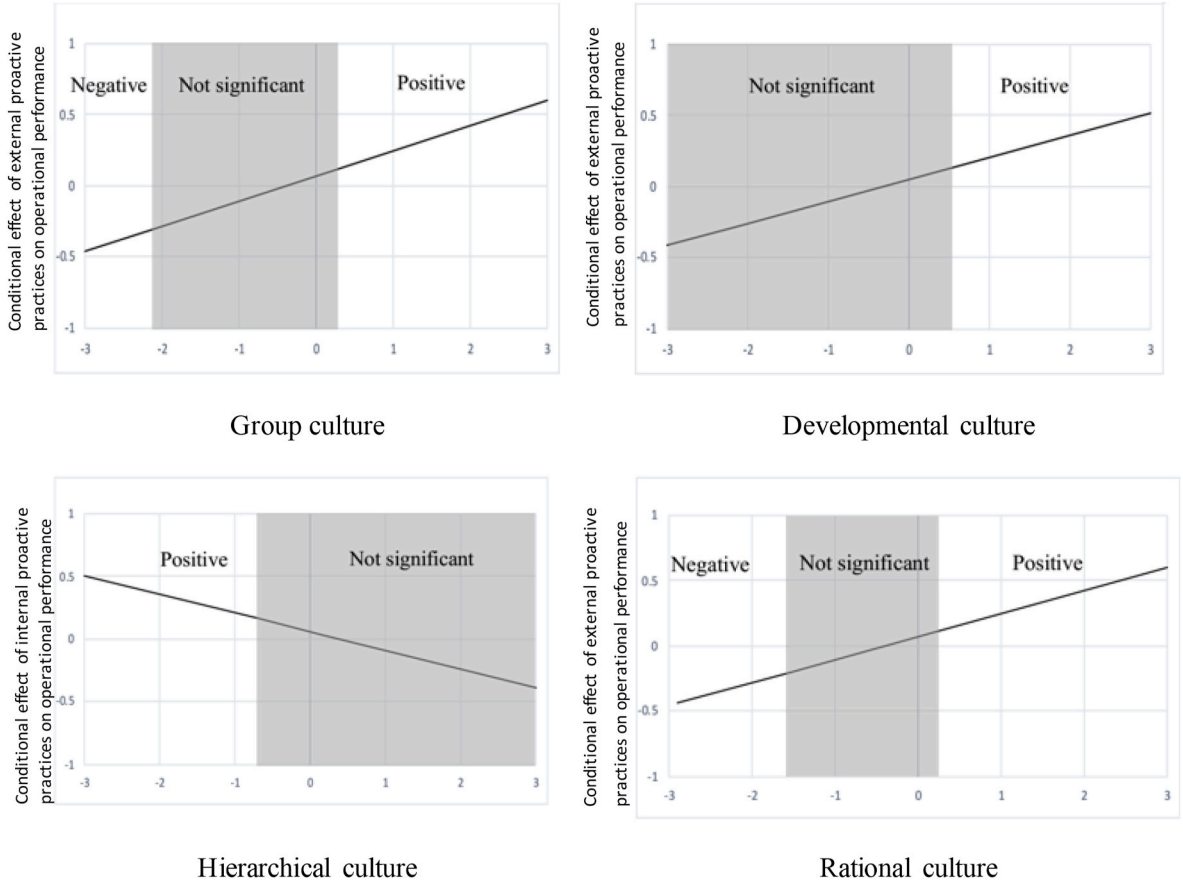

Fig. 3. Plots of the effects between culture and proactive environmental practices.

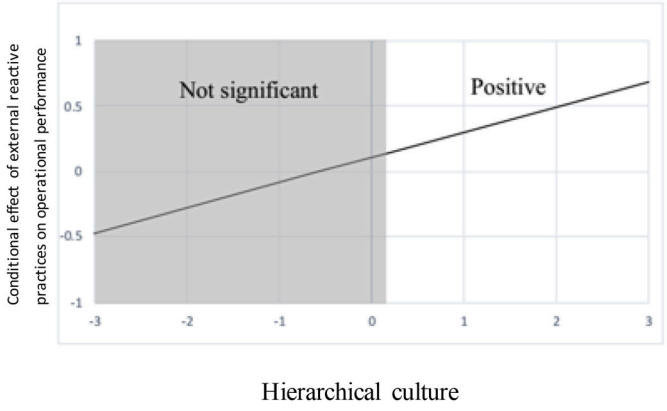

Fig. 4. Plot of the effect between culture and reactive environmental practices.

practice–culture interactions are that interactions between culture types and *internal* and *external proactive* environmental practices can have different effects on the development of the three key organizational capabilities (*stakeholder integration*, *higher-order learning*, and *continuous improvement*).

6.2. Distinguishing key organizational capabilities from internal and external proactive environmental practices: the role of culture types

We hypothesized that both developmental and rational culture types facilitate the development of a *stakeholder integration* capability from *proactive* environmental practices. Our results show that both developmental culture and rational culture positively moderate the relationship between *external proactive* environmental practices and firm performance but do not influence the competitive values of *internal proactive* practices. This suggests that *external*, rather than *internal*, *proactive* environmental practices are most likely to trigger the development of the capability of integrating stakeholders due to their broader scope and external focus. Firms characterized by a developmental culture are more innovative, flexible and willing to collaborate to find new solutions (Cameron and Quinn, 2011). This fits well with the need to collaborate with external stakeholders to tackle environmental issues (Lee and Kim, 2017), and fosters a stakeholder integration capability. Likewise, firms characterized by a rational culture are strongly competitive and market driven: they tend to forge close external partnerships in order to control their supply chains for a competitive advantage (Cameron and Quinn, 2011). These characteristics fit well with the need to collaborate with suppliers and they help in gaining an understanding of customer requirements in terms of sustainable products and, therefore, facilitate the development of *stakeholder integration* capabilities (Linnenluecke and Griffiths, 2010; Lee and Kim, 2017).

We hypothesized that both a developmental culture and a group culture could be facilitators in developing a *high-order learning* capability from *proactive* environmental practices, whereas a hierarchical culture could be an inhibitor. We indeed find that both developmental and group cultures positively moderate the relationship between *external proactive* environmental practices and firm performance, whereas a hierarchical culture has a significantly negative impact on the performance implications of *internal proactive* environmental practices. The results seem to suggest that both *internal* and *external proactive* environmental practices can trigger the development of *higher-order learning* capabilities. Firms characterized by a high developmental culture are generally agile and open to knowledge acquisition and creation (Cameron and Quinn, 2011). Such firms are quick to absorb new

knowledge from external stakeholders. They are viewed as learning firms and can therefore exhibit high-order learning capabilities in the process of implementing *external proactive* practices. A similar outcome is achieved by firms with a high group culture. These firms value collaboration and the participation of all internal stakeholders: they are flexible, and they tend to empower employees (Cameron and Quinn, 2011). In such firms, new ideas and knowledge acquired from external stakeholders are rapidly spread across the organization and absorbed by its employees (Linnenluecke and Griffiths, 2010; Lee and Kim, 2017), facilitating the development of a high-order learning capability. However, a hierarchical culture can be detrimental to the development of a high-order learning capability. The rigidity of a hierarchical organization does not fit with an *internal proactive* approach as this requires re-thinking and re-shaping the internal production process whereas, in a firm with a high hierarchical culture, the focus is on control rather than change, efficiency rather than learning.

We hypothesized that the group and rational culture types could be facilitators of a *continuous improvement* capability developed from *proactive* environmental practices. Our results show that both group and rational cultures have a significantly positive impact on the relationship between *external proactive* environmental practices and firm performance, but that these two culture types do not interact with *internal proactive* environmental practices. This suggests that *external*, rather than *internal*, *proactive* practices are most likely to trigger the development of a *continuous improvement* capability. Firms that are characterized as having a group culture encourage teamwork and they are quick to generate a consensus (Cameron and Quinn, 2011). A group culture facilitates translating new solutions, jointly developed with suppliers, into new products and processes, enhancing their *continuous improvement* capability (Linnenluecke and Griffiths, 2010; Lee and Kim, 2017). Firms characterized by a rational culture seek profits and are goal-driven (Cameron and Quinn, 2011). This fits well with the need to quickly implement solutions developed through collaborations with external stakeholders, and this fosters a *continuous innovation* capability when collaborating with supply chain partners.

6.3. The different roles of the three key capabilities in achieving competitive advantage from implementing proactive environmental practices

The additional analyses, depicted in Fig. 2, show that while very low levels of rational or group culture types can have a detrimental effect on the competitive benefits of *external* environmental practices, a low level of developmental culture or a high level of hierarchical culture do not lead to a decrease in firm performance. This suggests that the three key capabilities might have different roles in achieving a competitive advantage.

External proactive environmental practices will only lead to a negative performance if the group and/or the rational culture is at a low level. When looking at the effects on the specific capabilities, developed through the interaction between such culture types and practices, we observe that the only capability that rational and group cultures can facilitate is a *continuous improvement* capability. Furthermore, developmental culture and hierarchical culture do not relate to this capability. Therefore, we can infer that the *continuous improvement* capability is crucial for avoiding detrimental effects on firm performance from environmental practices. *Continuous improvement* is central to organizational capabilities, playing a double-edge role for achieving competitive advantage. When supported by an appropriate culture type, this capability can bolster competitive advantage. Conversely, if undermined by an inappropriate culture type, the absence of this capability can harm competitive advantage.

We did not find similar negative effects of the other culture types on performance, and indeed we found that achieving a certain cultural level can lead to a competitive advantage. This effect can be attributed to the presence of the other two key capabilities: *stakeholder integration* and *higher-order learning*. Since the absence of these two capabilities does not lead to a worse performance, while their strong presence can lead to an improved performance, we infer that these two capabilities are key building blocks in establishing organizational capabilities. For a firm to gain a competitive advantage from implementing *proactive* environmental practices, it needs to have sufficient levels of certain culture types to avoid hindering the development of a *continuous improvement* capability while also facilitating the development of *stakeholder integration* and *higher-order learning* capabilities. Although these findings are promising, further studies are needed to confirm the results, through explicitly measuring these capabilities.

6.4. Competitive value of reactive environmental practices and the contingent role of OC

Our baseline model also includes *reactive* environmental practices, such as pollution control measures in pursuit of a reduction in the risk of environmental accidents and spills. It is widely assumed that *reactive* environmental practices do not lead to competitively valuable capabilities (e.g., Hart, 1995; Hart and Dowell, 2011; Sharma and Vredenburg, 1998). It is therefore surprising that our study shows that *external reactive* environmental practices can contribute to firm performance, albeit only in firms characterized by a high hierarchy culture. Drawing on the contingent RBV, this finding suggests that a hierarchical culture facilitates the development of capabilities from *external reactive* environmental practices, which in turn lead to a competitive advantage. Sharma and Vredenburg's (1998) empirical study identified the presence of capabilities to minimize risk and liability and to achieve exemplary regularity compliance. However, on the assumption that all the organizations they analyzed were required to achieve these two objectives, the authors assumed that such capabilities had no competitive value. Moreover, while they found that organizations with a specific OC may develop leadership in environmental regulatory compliance, they did not include this evidence in their study's scope (believing it to be irrelevant). By combining these earlier observations with our results, we can argue that the development of a "*compliance capability*" from *external reactive* environmental practices can be fostered by a hierarchical culture, and that such a compliance capability can contribute to firm performance through risk avoidance (Gualandris et al., 2015). With the support of a high hierarchical culture that emphasizes control and accountability (Cameron and Quinn, 2011), supplier monitoring practices can be effective in identifying and mitigating environmental risk factors in supply chains. As a result, the likelihood that supply chain operations will be hampered by environmental accidents or disruptions will be reduced and, as a result, firm performance can improve.

6.5. Theoretical contributions

Our study makes three main theoretical contributions. First, previous studies have investigated various contextual factors that may affect a firm's ability to achieve a competitive advantage from implementing environmental practices (e.g., Xiao et al., 2018). Our study adds another contextual factor, OC, and provides empirical evidence of its influence on the environmental practice – firm performance relationship. The use of the contingent RBV perspective, combined with the CVF, enabled us to understand *how* OC affects the value creation potential of *proactive* environmental practices (Aragon-Correa and Sharma, 2003). Our results show that the development of valuable competitive capabilities from *proactive* environmental practices are facilitated by high levels of developmental, group, and rational culture types, together with a low hierarchical culture. Further, by distinguishing between *internal* and *external proactive* environmental practices, we find that external environmental practices have much higher potential than internal environmental practices in improving firm performance. As such, our findings add substantial insights into the value creation processes of implementing environmental practices in various cultural contexts. In this, we

complement past studies by analyzing OC as a driver of environmental management, by providing evidence supporting *a culture-as-moderator perspective* (Hardcopf et al., 2021; Kull and Wacker, 2010) as a route to sustainability.

Second, our study provides new insights into the different roles played by competitively valuable capabilities developed from environmental practice implementation. While there is substantial agreement regarding the general characteristics that capabilities should possess in order to generate competitive advantage, including being difficult to be identified and imitated by competitors (Barney, 1991), very little research has explored their *relative* importance (Grewatsch and Kleindienst, 2017). In terms of the three capabilities in Sharma and Vredenburg's (1998) study, which have all been found to be potential sources of competitive advantage (Yang et al., 2019), we infer that each of these three capabilities could have different roles in linking *proactive* environmental practices to firm performance. A *continuous improvement* capability is central to a firm's organizational capabilities, as its absence can be detrimental to firm performance. Conversely, its presence, in conjunction with the other two capabilities – *stakeholder integration* and *higher-order learning* – can benefit firm performance. This suggests that the capability of continuous improvement plays a key role in realizing the value of stakeholder integration and high-order learning.

Third, our study proposes a new, competitively valuable, capability that can be triggered by *reactive* environmental practices in firms that are characterized by a high hierarchical culture: *compliance* capability. As such, our results challenge the assumption – largely unquestioned in the sustainability literature – that *reactive* environmental practices do not lead to a competitive advantage. This finding also lends support to the theoretical proposition developed by Gualandris et al. (2015) – that supplier evaluation and monitoring can be a source of competitive advantage.

6.6. Managerial implications

Stakeholders are increasingly demanding that manufacturers minimize the environmental impact of their products and processes. As manufacturers strive for environmental sustainability, it becomes imperative that they improve environmental practices across their supply chains (Vachon and Klassen, 2008). While it is relatively easy to implement certain environmental practices within their organizations (Vachon and Klassen, 2008), the real challenge is to implement environmental programs across supply chains and to go beyond the low-hanging fruits in order to reap substantial benefits from environmental investments. Our results provide some guidance on how one can gain competitive values from environmental practices. Managers should first develop a clear understanding of their firm's culture, and the CVF help clarifying the main or stronger traits of their OC. Specifically, by applying our survey instrument (see Appendix B) to their organization, managers can assess their OC across the four fundamental traits distinguished by the CVF. This assessment is crucial because these traits can have a significant influence on the potential value creation of environmental practices. Firms with a high hierarchical culture may find it more beneficial to implement *external*, *reactive* environmental practices such as monitoring supplier sustainability. In contrast, *internal proactive* environmental practices, such as pollution prevention, are of greater competitive value for firms with a low hierarchical culture. For firms with high developmental, group, or rational cultures, investing in *external proactive* environmental practices could contribute significantly to a competitive advantage. Organizations should not only reconsider their approach to environmental management based on their dominant culture, they can also decide to develop a supportive OC that encourages the development of valuable organizational capabilities from specific environmental practices. For example, in this regard, our results suggest that organizations with a proactive environmental approach should consider investing in a cultural change to strengthen their developmental, group, or rational cultures if these are currently weak. Here, it has to be noted that changing an OC is difficult, and typically requires substantial investments and time. Managers should thus carefully diagnose their current OC, identify the preferred future culture, and develop actions to move from the current to the preferred culture (Cameron and Quinn, 2011).

6.7. Limitations and future research

We relied on cross-sectional data in exploring the influence of OC on environmental practice effectiveness. While cross-sectional survey-based studies have been the primary research design used to investigate the influence of culture on OM practice implementation and effectiveness (see the review by Marshall et al., 2016) and can provide important insights on supportive cultural traits for specific managerial practices (e.g., Hardcopf et al., 2021), the use of longitudinal data and alternative methods could complement our findings, providing an understanding of the dynamics of culture–practice interaction.

We have investigated culture at the plant level, collecting data from managers. The choice to focus on plant-level data is consistent with the aim of our research and typical of many OM studies involving culture (e.g., Naor et al., 2010; Pagell et al., 2014), as is the approach of relying on managers' perceptions of OC (Marshall et al., 2016). The inclusion of additional stakeholders, such as workers and members of the firm's supply chain, might provide more-nuanced results on the influence of culture. In addition, we measured OC using previously validated scales that address the characteristics of an organization in absolute terms. However, cultural differences between an organization and its suppliers might play a role in practice effectiveness (Cadden et al., 2013) and therefore warrant further investigation.

We focused on OC as a key contingency factor influencing the effectiveness of environmental practices on firm performance. However, we acknowledge that there are other managerial variables that also merit attention in future research. Potential contingency factors include leadership styles and organizational structure, among others. Future studies exploring these variables can enrich the understanding of this domain and provide additional insights for both theory and practice.

Finally, we used the contingency RBV as our theoretical lens, and this provided novel and powerful explanations for the influence of OC on the effectiveness of environmental practices. However, we did not explicitly measure organizational capabilities and we would encourage future researchers to apply more advanced research designs to explicit capture these capabilities. Here, our inferences can be used to guide further research towards providing empirical validation.

CRediT authorship contribution statement

Thomas Bortolotti: Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Stefania Boscari:** Writing – review & editing, Writing – original draft, Visualization, Investigation, Conceptualization. **Cheng-Yong Xiao:** Writing – review & editing, Writing – original draft, Visualization, Conceptualization.

Data availability

The authors do not have permission to share data.

APPENDIX A. Environmental practices

Construct	Items	Composite Reliability	Factor loading
Proactive Internal	**Reducing waste in internal processes (e.g., improving yield or efficiency)**	0.84	0.70
	Pollution prevention (eliminating emissions or waste)		0.82
	Decreasing the likelihood or impact of an environmental accident		0.81
	Environmental improvements in the disposition of your organization's scrap or excess material (re-use, recycling, etc.)		0.74
Proactive External	**Encouraging suppliers to improve the environmental performance of their processes**	0.88	0.85
	Co-development with suppliers to reduce the environmental impact of the product (e.g., eco-design, green packaging, recyclability)		0.84
	Involvement of suppliers in the re-design of internal processes (e.g., remanufacturing, reduction of by-products)		0.84
Reactive Internal	**Complying with a customer's supplier code of conduct**	0.79	0.73
	Complying with an industry-wide code of conduct		0.80
	Other compliance or auditing program focused on your plant (not on your suppliers)		0.79
Reactive External	**Requesting that your suppliers sign a code of environmental conduct**	0.77	0.64
	Incorporating environmental considerations in evaluating and selecting suppliers		0.77
	Providing design specification to suppliers in line with environmental requirements (e.g., green purchasing, black list of raw materials)		0.74

APPENDIX B. ORGANIZATIONAL CULTURE

Construct	Items	Composite Reliability	Factor loading
Hierarchical	A person who wants to make his own decisions would be quickly discouraged.	0.87	0.70
	Even small matters have to be referred to someone higher up for a final answer.		0.79
	I have to ask my boss before I do almost anything.		0.91
	Any decision I make has to have my boss's approval.		0.73
Rational	Our incentive system encourages us to vigorously pursue plant objectives.	0.87	0.82
	The incentive system at this plant encourages us to reach plant goals.		0.89
	Our incentive system is consistent with our plant goals.		0.77
Group	Our supervisors encourage the people who work for them to work as a team.	0.80	0.75
	Our supervisors encourage the people who work for them to exchange opinions and ideas.		0.74
	Our supervisors frequently hold group meetings where the people who work for them can really discuss issues and share ideas.		0.78
Developmental	We pursue long-range programs, in order to acquire manufacturing capabilities in advance of our needs.	0.75	0.70
	We make an effort to anticipate the potential of new manufacturing practices and technologies.		0.71
	We are constantly thinking of the next generation of manufacturing technology.		0.73

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