

A Pleasant Surprise of Proactive Environmental Strategy in Smes? A Novel Mechanism to Improve New Product Development Performance

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ABSTRACT

Resource constraints often impede the implementation of proactive environmental strategy (PES) in small and medium-sized enterprises (SMEs), potentially reducing their profitability. Given the importance of PES for SMEs, the implementation and outcomes of PES in resource-constrained contexts have drawn scholarly and practical interest. Applying the RBV's resource-capability-performance framework, this study examines the issue through a three-wave survey of 176 Chinese SMEs. The findings reveal that the relationship between PES and new product development performance is sequentially mediated by environmental collaboration and technological opportunism. Additionally, the higher the level of organizational risk-taking tolerance, the greater the positive effect of PES on new product development performance, as organizational risk-taking tolerance facilitates internal integration and allows extra risks. The findings offer theoretical and practical insights for SMEs to overcome resource constraints, integrate social and environmental objectives into economic activities, and achieve competitive advantage alongside ecological sustainability.

Keywords: proactive environmental strategy; environmental collaboration; technological opportunism; new product development performance; organizational risk-taking tolerance.

INTRODUCTION:

Against the backdrop of increasingly severe environmental challenges and stringent regulations, proactive environmental strategy (PES) has become a critical initiative for enterprises pursuing sustainable development and competitive advantage. Defined as voluntary activities that integrate environmental objectives into business strategies (Aragón-Correa & Rubio-López, 2007), PES has been extensively studied in large firms, yet its mechanisms and effects in SMEs remain insufficient, largely due to perceived resource constraints to invest for environmentalism. (Seroka-Stolka & Fijorek, 2020). However, as SMEs play a vital role in socio-economic and environmental coordination, investigating PES within this context is both relevant and imperative. This practice is highly significant, as a growing number of SMEs have enhanced both product quality and novelty through resource management and innovation, while proactively fulfilling environmental responsibilities, ultimately achieving superior performance (Sarfo et al., 2024). Consequently, PES has emerged as a key driver enabling SMEs to develop new products marked by novelty and high quality beyond merely eco-friendly products, thereby improving new product development performance (NPDP).

However, existing studies said little about NPDP, even if scholars have paid increasing attention to the

outcomes of PES in SMEs and these studies have explored the positive effects of PES on SMEs, such as market performance (Nguyen & Adomako, 2021), environmental performance (Testa et al., 2015), and competitive advantages (Mishra & Agarwal, 2010). The critical role of NPDP in enterprises' survival and competitive advantage has been examined in prior studies (Tian et al., 2023), and NPDP has become an important indicator of SMEs' resilience and sustainable development (Jamali et al., 2014). Given the significance of NPDP, the missing link between PES and NPDP may hinder the understanding of the intermediate outcomes of PES that could allow SMEs to gain a competitive advantage. To fill this gap, the specific path that links PES and NPDP must be identified.

PES guides enterprises to mitigate the environmental impact of their business (Aragón-Correa & Rubio-López, 2007). This entails investments in equipment upgrading, improved production technologies and processes, and the implementation of full product life-cycle management, including material redesign or development. Consequently, PES not only promotes environmental practices for green transformation but also drives firms to integrate resources (Shah & Soomro, 2021) and enhance capabilities (Yang et al., 2019), fostering continuous innovation and product quality improvement. NPDP suggests the comprehensive

evaluation of the novelty of new products and their market performance (Carson et al., 2012). Novelty arises from attributes that meet market demands through functional deconstruction and recombination (Nasirov et al., 2021), often is enhanced by technological advancements that improve product functionality (Mariani & Dwivedi, 2024). However, developing new products with novel technologies poses significant challenges for resource-constrained SMEs, as new technologies developing demands substantial resources and strong capabilities Hervas-Oliver et al. (2015). Thus, SMEs' resource and capability turn to be the missing link between PES and NPDP.

Drawing on Helfat and Peteraf (2003), a resource is an asset or production input, whether tangible or intangible, that an organization owns, controls, or can reliably access on a sustained basis. An organizational capability refers to a set of routines that effectively execute coordinated tasks to achieve strategic objectives. Organizational resources and capabilities are the central role for firm performance (Wibbens, 2021), where capabilities building relies on the acquisition of organizational resources and the complex interactions among them (Makadok & Walker, 2000). To elucidate the critical role of resources and capabilities in the relationship between PES and NPDP within resource-constrained SMEs, this study adopts RBV's resource-capability-performance framework recommended by scholars (Ding et al., 2023), enabling separate examination of their effects on firm performance.

Helfat et al. (2023) reaffirmed the relevance of the RBV in sustainable development, highlighting the role of stakeholders such as suppliers as sources of strategic resources (Barney, 2018). When internal resources are insufficient, enterprises can access external resources through stakeholder collaborations to build specific capabilities (Gibson et al., 2021), thereby advancing environmental and social sustainability (Lewis et al., 2014). While various forms of collaboration has been examined, such as R&D (Delgado-Verde & Diez-Vial, 2024) and innovation collaboration (Blais & Cloutier, 2023) in NPD, environmental collaboration remains understudied. Defined as inter-organizational collaboration with suppliers centered on shared environmental goals (Grekova et al., 2016), environmental collaboration serves as a relational resource supports sustainability (Kulangara et al., 2022), and innovation (Borah et al., 2024). In this study, we examine environmental collaboration as a complementary resource that mitigates resource constraints in SMEs by facilitating knowledge, equipment, and technology exchange, thus supporting NPDP. Additionally, in dynamic technological environments, the ability to sense and respond to new technologies is critical for NPDP (Nasirov et al., 2021). Technological opportunism, a sense-and-respond capability to technological changes (Srinivasan et al., 2002) serves as a form of benign opportunism that enhances firm performance (Li et al., 2023) and innovation (Urban & Maphumulo, 2021) by capturing market opportunities without detrimental behaviors.

Under the PES mandate shifting from pollution remediation to prevention, SMEs are compelled to proactively monitor and anticipate technological trends (Chang & Sam, 2015), creating opportunities to develop high-quality new products that meet market demands. Accordingly, we introduce technological opportunism as a capability fostered by PES to examine its effect on NPDP. Furthermore, environmental collaboration with suppliers enhances access to technological information and strengthens both the willingness and capacity for technology adoption. Therefore, we also investigate the sequential mediating effects of environmental collaboration and technological opportunism in the relationship between PES and NPDP.

Based on the RBV, contingent factors are important in the relationship between PES and performance (Aragon-Correa & Sharma, 2003). PES requires riskier investments (Sharma, 2000), and innovation activities such as NPD are inherently risky (Chen et al., 2023). Risk-taking tolerance is therefore particularly critical for SMEs, which often lack sufficient resources to absorb additional risks. Organizational risk-taking tolerance is an important organizational climate that supports risk-taking and controlling behaviors (Hock-Doeppen et al., 2021; Smith et al., 2005), and matters in SMEs. It facilitates innovation and R&D investment (Expósito et al., 2021; Liu & Wang, 2020), by enhancing resource and knowledge management, encouraging communication and internal information sharing (Hock-Doeppen et al., 2021), and providing greater trial-and-error opportunities for successful innovation. Thus, organizational risk-taking tolerance is treated as a key contingent factor in SMEs for explaining the relationship between PES and NPDP.

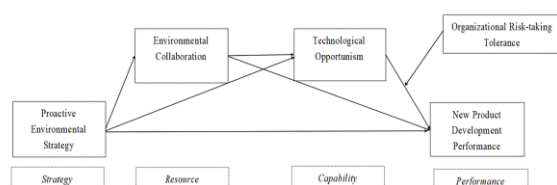
Our study contributes to the literature in several ways. First, we explore the relationship between PES and NPDP that have, to date, remained largely disconnected. Prior studies mainly focus on the effect of PES on firm performance (Li et al., 2022) and environmental performance, neglecting NPDP which is featured with high quality and novelty. In this study, we challenge the notion that environmental strategies are incompatible with the NPD with high-energy-consuming (Hengst et al., 2020) by discovering a new path to develop new product with technologies to the basic function to meet upcoming market demands. Second, we theoretically explain how PES impact on NPDP in SMEs based on the RBV's resource-capability-performance framework. Previous RBV-based studies on PES outcomes did not tell the nuances between resources and capabilities, leaving it unclear how resource-constrained SMEs overcome resource bottlenecks in PES implementation. From a holistic RBV perspective, we emphasize the critical bridging role of environmental collaboration, connecting collaborative relationships with resource supplementation, making it essential for NPDP (Barney, 2018). Third, our study demonstrates that technological opportunism, as an organizational capability emerging from collaborative relationship, empowers SMEs to develop new products by incorporating new technologies. Our findings further indicate the existence

of benign opportunism, aligning with previous studies by affirming the positive role of technological opportunism in the relationship between PES and NPDP. Finally, we address the risks inherent in PES and NPDP for SMEs, examining how organizational risk-taking tolerance moderates this relationship. Our analysis offers new insights into how the effect of PES may vary with risk tolerance levels. Practically, this study clarifies the process mechanisms and outcomes of PES, countering prior ambiguities and empowering SMEs to proactively address environmental challenges and gain competitive advantage.

Theoretical background and hypothesis development

According to the RBV, possessing valuable, rare, and inimitable resources is necessary yet insufficient for achieving good firm performance and competitive advantages; these outcomes also depend on organizational capabilities that emerge from complex interactions among resources (Barney, 1991; Grant, 1991; Peteraf, 1993). Resource is a critical determinant of firm performance, being necessary for the production of market offerings that create economic value (Helfat et al., 2023). Enterprises frequently access external resources through inter-organizational collaboration to leverage partners' expertise and assets (Lavie, 2006; Wassmer et al., 2017), particularly under resource constraints or strategic weaknesses (Ahuja, 2000). As a kind of special resource, organizational capabilities are embedded in organizational processes and practices, serving as the glue that binds an enterprise's resources to facilitate value creation (Makadok & Walker, 2000). They seldom emerge spontaneously; rather, they are built through complex resource interactions and accumulations (Martin et al., 2017), which makes them difficult to replicate or transfer. For resource-constrained SMEs, acquiring external resources and developing specific capabilities are essential to achieving competitive advantage and superior performance. In this study, the RBV's resource-capability-performance framework offers a holistic explanatory perspective for how SMEs leverage relational resources and develop capabilities to enhance NPDP. Figure 1 illustrates our research framework, which summarizes the above.

Figure 1. Research Framework



PES and SMEs' NPDP

NPDP primarily depends on the product quality and novelty (Atuahene-Gima & Li, 2004), which encompass features and performance that meet emerging customer needs. Resource integration contributes to the novelty of new products (Lyu et al., 2022), while organizational

capabilities ensure their development and production (Arnett et al., 2018). Both aspects play significant roles in enhancing NPDP. PES drives resource integration in SMEs while facilitating the building and improvement of organizational capabilities to improve efficiency, accelerate speed, and empower novelty in new product development, thereby promoting NPDP. Specifically:

First, under strategic guidance, SMEs engage in internal resource integration and external collaboration to build a multidimensional resource base for NPDP. Internally, PES promotes cross-departmental integration (Shah & Soomro, 2021) leveraging SMEs' flat structures to concentrate limited resources into key areas and enhance reallocation efficiency, thereby increasing flexibility in product design and production. Externally, as environmental sustainability exceeds individual capabilities, especially for resource-constrained SMEs, PES drives them to pursue collaboration for accessing niche ecological resources (Lewis et al., 2014). Green supply chain collaboration for acquiring heterogeneous resources not only add novelty to product but also enables access to market demand information (Kulangara et al., 2022), enabling targeted R&D to better meet personalized customer needs. Secondly, driven by PES objectives, a capability-forcing mechanism emerges in SMEs, facilitating technical support for NPDP. PES pushes firms to adopt innovative approaches such as clean technologies and circular designs (He et al., 2022), thereby compelling restructuring of R&D and production systems. This shift enhances energy efficiency, reduces operational costs, optimizes processes, and improves production efficiency. Consequently, it shortens developing cycle for new products, enabling market share capture and superior performance. Finally, PES facilitates the interaction between organizational resources and capabilities, promoting self-reinforcing competency growth. This process enables continuous accumulation and renewal of resources, while capabilities improve steadily, enhancing the conversion of resources into productivity. As a result, SMEs gain access to advanced technical support during product development, further advancing NPDP. Thus, we propose:

Hypothesis 1: PES is positively related to SMEs' NPDP.

The mediating role of environmental collaboration

The RBV interprets enterprise behavior as a search for resources to achieve competitive advantages. This desire for resources motivates enterprises to develop and utilize collaborative relationships when internal resources are insufficient (Barney, 2018), as resources underpin both innovation and performance (Helfat et al., 2023). PES impose resource demands on SMEs, which, due to their constrained resources, often depend on collaborations to access external resources. Environmental collaboration, a form of inter-organizational collaboration between focal firms and their suppliers, grounded in shared environmental objectives and benefits (Grekova et al., 2016), constitutes a key intangible resource for pursuing sustainability (Kulangara et al., 2022). SMEs may turn to environmental collaboration to realize resource investment. Specifically:

First, PES necessitates investments in clean production (Martinez-Alonso et al., 2025), yet SMEs frequently lack the capacity for independent R&D in green technologies or alternative materials due to financial and expertise constraints (Hillary, 2004; Murillo-Luna et al., 2008). To achieve cleaner production, SMEs may collaborate with suppliers to bridge productivity gaps and adopt environmentally sustainable practices (Kulangara et al., 2022). Second, PES needs enterprises to accumulate and create new knowledge on environmental practice (Yang et al., 2019), however, acquiring specialized expertise and techniques is often costly, inefficient, and time-consuming (Jakobsen & Steinmo, 2016) particularly for non-green SMEs. Consequently, SMEs tend to engage proactively with suppliers through non-market mechanisms such as “learning by doing” or intensive observation and communication to facilitate knowledge transfer (Ahuja, 2000). Third, as PES involves inherent risks (Aragón-Correa & Rubio-López, 2007), SMEs, which typically exhibit lower risk resilience, often collaborate with suppliers on innovation to reduce R&D investments, lower costs, and mitigate trial-and-error risks (Chiou et al., 2011). Thus, through PES adoption, SMEs may enhance collaboration with suppliers who share common environmental goals, thereby supplementing their resource deficiencies.

As key drivers of innovation and production, the increased environmental collaboration will in turn promote the NPDP in SMEs. Such collaboration allows SMEs to augment their environmental production without additional investment, freeing up resources for other innovation activities. An expanded resource pool facilitates product development, while collaboration with suppliers fosters joint green innovation (Kulangara et al., 2022). This helps SMEs overcome resource limitations and gain novel ideas, enhancing product originality. Therefore, a higher degree of environmental collaboration positively influences NPDP at the resource level. We propose:

Hypothesis 2: Environmental collaboration mediates the relationship between PES and SMEs' NPDP.

The mediating role of technological opportunism

Technological opportunism, a distinct organizational capability, enables enterprises to sense and respond to new technologies in a manner consistent with fairness (Srinivasan et al., 2002). It encompasses both sensitivity to technological advancements and the willingness and capacity to adopt them. As PES demands a shift from pollution remediation to prevention, with technology as a pivotal support (Chang & Sam, 2015), SMEs must engage in technology scanning and proactively forecast trends to plan their technological responses.

First, PES encourages SMEs to focus on new technologies, thereby enhancing their responsiveness to technological progress. Proactive enterprises can anticipate regulatory shifts, seize opportunities for technological transition, and adopt clean production methods (Vecchiato et al., 2024). PES also facilitates SMEs' integration into innovation ecosystems, such as solid-state battery alliances in the automotive sector, enabling priority access to strategic roadmaps (Benitez et al., 2020). Second, PES encourages SMEs to establish active learning mechanisms and cross-disciplinary talent reserves, improving their absorptive capacity for technological information (Alberto Aragon-Correa et al., 2020). To keep pace with emerging environmental technologies, SMEs monitor industry trends, such as through patent databases and academic papers, institutionalizing learning processes, fostering employees' technology scanning habits, and improving technological literacy. This strengthens their ability to acquire and assimilate technological knowledge. Furthermore, SMEs deepen external collaborations with industry and academia, building talent pools to boost the adoption and application of new technologies (Alcalde-Heras & Carrillo, 2025). Lastly, responsiveness to new technologies is critical for seizing technological opportunities. PES drives SMEs to optimize organizational processes, thereby accelerating their reaction to technological information. Pressures to improve resource efficiency push resource-constrained SMEs toward lean operations (Battistella et al., 2023). By Leveraging flat structures and delegated decision-making—such as through innovation teams, SMEs can reduce hierarchical approvals and shorten technology evaluation cycles. And, by promoting cross-functional collaboration, they can allocate resources flexibly to rapidly transform technologies into outputs. In summary, PES enhances SMEs' technological opportunism, their sense-and-respond capability, by improving sensitivity, response capacity, and response speed to technological opportunities.

Sensing and responding to external environmental change have always been key drivers of performance (Teece, 2007), so technological opportunism will empower SMEs to boost their NPDP. Technological opportunism enables SMEs to enhance their NPDP by reflecting innovative capability, a fundamental premise of NPDP. First, sensing capability enables enterprises to

identify and capture new information from technological developments that is a key source of innovation for new products (Cho et al., 2022), and to address technical challenges that arise during development (Brown & Eisenhardt, 1995). Second, responding capability allows firms to leverage existing resources and know-how to assimilate and apply new technologies in product development (Yu et al., 2014). Finally, technological breakthroughs through new products can enable enterprises to gain market share or achieve leadership (Gangwani & Bhatia, 2024). Thus, technological opportunism, as an organizational capability emerging from PES in SMEs, enhances the technological level of products to better meet market demand, thereby positively influencing NPDP (Tseng et al., 2022). Thus, we propose:

Hypothesis 3: Technological opportunism mediates the relationship between PES and SMEs' NPDP.

The relationship between environmental collaboration and technological opportunism

The RBV suggests that organizational capabilities, as a special type of resource, seldom emerge spontaneously. Instead, they are generally developed through complex, iterative interactions and the gradual accumulation of resources over time (Makadok & Walker, 2000). Environmental collaboration provides relational resources that enable SMEs to interact with suppliers on common environmental issues, facilitating access to new technological information, promoting knowledge transfer, and supporting capability building. Specifically:

First, environmental collaboration fosters technological opportunism by being future-oriented. As a proactive environmentally focused resource, environmental collaboration helps predict future market demands and creates opportunities for enterprises to capture new technologies (Blome et al., 2014; Bowen et al., 2001). And then, new technologies often come from outside the market environment, such as from suppliers, scientific research institutions, and universities (Srinivasan et al., 2002). Collaborating with suppliers shared common environmental goal facilitates cross-domain information integration, breaking down information silos, and enables enterprises to access a wider range of technological trends and cutting-edge research findings, as well as quickly obtain market trends, policy directions, or competitors' technological movements to reduce information asymmetry (Akhtar et al., 2023). Furthermore, collaborating with suppliers also promote enterprises' resource complementary and capability synergy. SMEs may lack independent R&D capabilities, but by collaborating with technology suppliers, they can not only share R&D, experimental equipment, or data resources, accelerating technology implementation, but also absorb new technological knowledge and strengthen internal digestion and re-innovation capabilities with experience exchange (Kulangara et al., 2022). Finally, collaborative relationships is related to

reducing innovation risk, and rapid iteration and feedback. Environmental collaboration allow SMEs to share the costs and risks associated with exploring new technologies, encouraging more proactive experimentation (Adomako & Tran, 2022), as well as real-time testing of technological feasibility, shortening the cycle from concept to market (Akhtar et al., 2023). Thus we assume that environmental collaboration can help SMEs to be sensitive to the information about new technologies and be willing and able to utilize new technologies with lower cost and risks and we propose:

Hypothesis 4: Environmental collaboration is positively related to technological opportunism.

Sequential mediating roles of environmental collaboration and technological opportunism

The RBV's resource–capability–performance framework offers a holistic lens through which to examine the distinct roles of resources and capabilities for performance. It underscores the importance of organizational resources in building capabilities and highlights capabilities as a vital platform for resource deployment and value creation (Makadok & Walker, 2000; Peteraf, 1993). An enterprise's performance depends significantly on its specific organizational resources and capabilities. As a resource-intensive strategy, PES requires substantial resources to achieve superior performance (Sharma, 2000). Under these circumstances, SMEs with limited internal resources must overcome resource bottlenecks before effectively utilizing them to build capabilities. External resources thus serve as a critical supplement, making environmental collaboration an ideal mechanism for SMEs to address environmental challenges. Through such collaboration, focal enterprises engage frequently with suppliers and immerse themselves in new technologies and markets beyond their boundaries, fostering technological opportunism. This, in turn, enables organizations to acquire knowledge about new market demands and technological developments, creating opportunities for developing new product and enhanced NPDP. Accordingly, based on the RBV framework, PES positively influences NPDP in SMEs through the sequential mediation of environmental collaboration and technological opportunism. We thus propose:

Hypothesis 5: Environmental collaboration and technological opportunism sequentially mediate the positive relationship between PES and NPDP.

Moderating effects of organizational risk-taking tolerance

In assessing the competitive value of organizational resources and capabilities under PES, environmental variation must be considered. SMEs face dual risks from both PES and innovative activities like new product development. Organizational risk-taking tolerance, which is a key aspect of organizational climate, facilitates exchange and experimentation (Ekvall, 1996),

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hereby influencing the relationship between PES and NPDP.

First, enterprises with higher level of organizational risk-taking tolerance are often more receptive to external information (Smith et al., 2005). This openness enhances technological opportunism, enabling more extensive and profound scanning and response to external technological developments, which are perceived as opportunities rather than threats. Second, a risk-tolerant culture facilitates information and knowledge flow across departments, allowing rapid acquisition and assimilation of new technological knowledge. This process helps identify opportunities to boost creativity and innovation (Choo, 2013), thereby supporting the application of emerging technologies in product development and innovative functional design. Thus, it helps enterprises in seizing market opportunities and facilitating market entry. Moreover, organizational risk-taking tolerance fosters a climate that encourages experimentation and risk-taking, thereby increasing the willingness to engage in trial-and-error processes (Hock-Doepgen et al., 2021). Given the high failure rates and uncertainties inherent in technology-driven new product development (Urbig et al., 2011), even capable enterprises face challenges in adopting emerging technologies. Successful integration of new technologies requires continuous experimentation. A higher level of risk-taking tolerance provides a buffer for such behaviors, enabling more diverse approaches to technology adoption, greater testing opportunities, and more innovative solutions (Rehman et al., 2024). We therefore propose that higher organizational risk-taking tolerance strengthens the positive effect of technological opportunism on NPDP.

In exploring how SMEs use relational resources to develop specific organizational capabilities for NPDP, technological opportunism is the another core mechanism that affects NPDP. The effect of PES on NPDP is sequentially mediated by environmental collaboration and technological opportunism; therefore, the positive impact of organizational risk-taking tolerance on the relationship between technological opportunism and NPDP helps predict the relationship between PES and NPDP through environmental collaboration and technological opportunism. Thus, we propose:

Hypothesis 6: Organizational risk-taking tolerance strengthens the positive relationship between technological opportunism and NPDP (H6a) and between PES and NPDP (H6b).

METHODS

Sample and data collection

We collected multi-wave survey data from SMEs in Eastern, Southern, and Central China based on the criterion of SMEs: fewer than 1000 employees (National Bureau of Statistics of China, 2012). Chief executive officers (CEOs) were the main respondents in this survey, as they conduct the day-to-day management of enterprises with fewer hierarchical levels in the context

of SMEs (Sine et al., 2006). We received assistance from the local administrative offices in delivering the surveys. Environmental issues are crucial for local officers, who often personally get acquisition of CEOs of enterprises in their district. Such interpersonal relationships are very important in Chinese culture, which helped boost response rates (Chen & Nadkarni, 2016).

We adopted Podsakoff's questionnaire design process to minimize the risk of common method variance (Podsakoff et al., 2003). Appropriate measurement indicators were selected, and the instrument was translated into Chinese and then back-translated. We contacted the head offices of 320 enterprises to obtain approval for our survey several times with the help of local governments and conducted pilot surveys with 15 CEOs. Subsequently, we administered the formal surveys over three periods. The first wave (t1) measured PES, organizational risk-taking tolerance, and control variables using 320 distributed questionnaires and received responses from 316 enterprises. Four weeks later, in the second wave (t2), we received responses from 265 enterprises regarding environmental collaboration and technological opportunism. Four weeks later, we received responses from 225 enterprises in the third wave (t3) on NPDP. 176 matched responses were obtained from the three surveys, and 49 invalid questionnaires were deleted, with a response rate of 55 percent. In our sample of SMEs, 22.8 percent had fewer than 50 employees, 66.8 percent had 50-200 employees, and 10.4 percent had 200-1000 employees. High- and low-technology industry enterprises accounted for 26.7 percent and 73.3 percent of the sample, respectively.

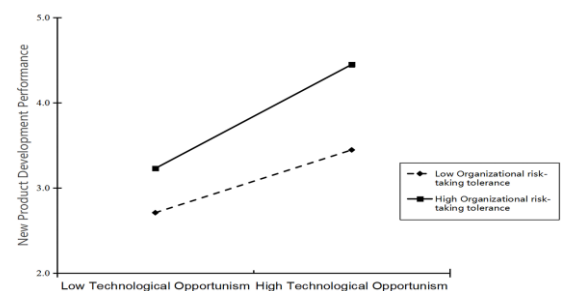


Fig. 2. Interaction Plot for the Influence of Organizational Risk-Taking Tolerance on the Technological Opportunism–NPDP Relationship.

Measures

We measured the study variables using seven-point Likert scales ranging from “1” (strongly disagree) to “7” (strongly agree). We included several control variables, which are discussed below.

Proactive environmental strategy was measured based on Murillo-Luna et al. (2008) and included 14 measurement items. This scale captures how much effort enterprises devote to environmental protection and improvement. Questions included, “My firm attempts to substitute the raw materials/products used that pollute the most with others that pollute less.” In the present study, Cronbach’s α was 0.963 for this scale.

Environmental collaboration was assessed based on Gölgeci et al. (2019) using six measurement items, including “Our firm cooperates with its suppliers to achieve environmental objectives.” Cronbach’s α was 0.944 for this scale.

Technological opportunism was measured using a tool developed by Srinivasan et al. (2002). The eight items on the scale included “We are often one of the first in our industry to detect technological developments that may potentially affect our business” and Cronbach’s α was 0.968 for this scale.

New product development performance was measured based on Carson et al. (2012). Typical items included “The product performed well in terms of sales” and Cronbach’s α was 0.963 for this scale.

Organizational risk-taking tolerance was measured based on Hock-Doepgen et al. (2021). Typical items include “Our company places high value on taking risks,

even if there are occasional mistakes” and Cronbach’s α was 0.931 for this scale.

Control variables. The research model included four control variables. First, we controlled for new product type (0, “radical,” and 1, “incremental”) as this has significant effects on a new product’s performance (Atuahene-Gima & Li, 2004). In addition, industry type was bifurcated and used to reflect firms’ degree of technological sophistication (Li & Atuahene-Gima, 2001): Enterprises in highly technologically sophisticated industries were coded as 0; otherwise, they were coded as 1. We also controlled for firm ownership because independent and sponsored firms may differ in their level of resources for strategic decisions and actions (0, “independent firm,” and 1, “sponsored firm”). Finally, we controlled competitive intensity, as it may positively affect NPDP (Lyu et al., 2022). The scale used in this study was developed by Jaworski and Kohli (1993), with typical items including “Competition in our industry is cutthroat” and Cronbach’s α was 0.861 for this scale.

MEASUREMENT MODEL ASSESSMENT

We assessed content, convergent, and discriminant validity following the recommendations of Hair et al. (2019).

Content validity

Table 1 presents the factor loadings of all items, each exceeding 0.60, which are above the accepted threshold and account for at least 50% of the variance in the indicators (Niemand & Mai, 2018). The scales, drawn from established prior studies, were adapted into Chinese using a translation-back-translation procedure to ensure conceptual and cultural appropriateness. This process involved independent translation by a management expert and three doctoral students, followed by consensus-building discussions. The Chinese version was then reviewed by ten senior executives to verify congruence with the original English version and its relevance within the Chinese context, resulting in a validated questionnaire for subsequent analysis.

Convergent validity

We used average variance extracted (AVE) and composite reliability (CR) to examine convergent validity (Fornell & Larcker, 1981). As Table 1 shows, the AVE values all exceeded the recommended threshold of 0.50, ranging from 0.651 to 0.792. By calculating the CR values, we obtained the empirical results presented in Table 1, in which all the CR values were well above the 0.70 benchmark, ranging from 0.931 to 0.968. All the results obtained in this study indicated high convergent validity.

Table 1. Standardized Factor Loadings and Convergent Validity

First order factors	Items	SFL	AVE	CR
Proactive environmental strategy (PES)	PES1	0.81	0.651	0.963
	PES2	0.79		
	PES3	0.85		
	PES4	0.81		
	PES5	0.80		
	PES6	0.82		
	PES7	0.78		
	PES8	0.80		
	PES9	0.83		
	PES10	0.78		

	PES11	0.82		
	PES12	0.824		
	PES13	0.789		
	PES14	0.805		
Environmental collaboration (EC)	EC1	0.844	0.740	0.945
	EC2	0.845		
	EC3	0.871		
	EC4	0.867		
	EC5	0.881		
	EC6	0.853		
Technological opportunism (TO)	TO1	0.887	0.792	0.968
	TO2	0.895		
	TO3	0.863		
	TO4	0.882		
	TO5	0.904		
	TO6	0.889		
	TO7	0.901		
	TO8	0.896		
New product development performance (NPDP)	NPDP1	0.87	0.743	0.963
	NPDP2	0.868		
	NPDP3	0.856		
	NPDP4	0.857		
	NPDP5	0.852		
	NPDP6	0.828		
	NPDP7	0.895		
	NPDP8	0.877		
	NPDP9	0.854		
Organizational risk-taking tolerance (ORT)	ORT1	0.859	0.772	0.931
	ORT2	0.911		
	ORT3	0.861		
	ORT4	0.883		

Discriminant validity

To establish discriminant validity, we first assessed the distinctiveness of the study variables using Mplus 7.0 prior to hypothesis testing. Following Podsakoff et al. (2003), seven nested models were compared against a five-factor model. As Table 2 shows, the five-factor model exhibited an acceptable fit, $\chi^2/df = 1.109$ (852.776/769), RMSEA = 0.025, SRMR = 0.043, CFI = 0.988, and TLI = 0.987, and outperformed all alternative models (for example, two four-factor models, two three-factor models, one two-factor model, and one one-factor model).

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We also assessed discriminant validity using the Fornell and Larcker criterion. As shown in Table 3, the square roots of the AVEs (bolded) exceed the inter-construct correlations, confirming discriminant validity (Fornell & Larcker, 1981).

Table 2. Fitness of Nested Models

Measurement Models	χ^2/df	CFI	TLI	SRMR	RMSEA
five-factor model: PES, EC, TO, NPDP, ORT	1.109	0.988	0.987	0.043	0.025
four-factor model: PES+EC, TO, NPDP, ORT	2.275	0.855	0.846	0.120	0.085
four-factor model: PES, EC+TO, NPDP, ORT	3.115	0.759	0.745	0.141	0.110
three-factor model: PES, EC+TO, ORT+NPDP	3.791	0.681	0.663	0.153	0.126
three-factor model: PES+ORT, EC+TO, NPDP	3.848	0.675	0.657	0.161	0.127
two-factor model: PES+ORT, EC+TO+NPDP	4.831	0.562	0.538	0.174	0.148
one-factor model: PES+ORT+EC+TO+NPDP	6.940	0.319	0.284	0.236	0.184

Notes: N = 176, where PES = proactive environmental strategy; EC = environmental collaboration; TO = technological opportunism; NPDP = new product development performance; ORT = organizational risk-taking tolerance. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Common-method bias assessment

In this study, self-report questionnaires were administered with multiple safeguards to ensure data quality and ethical compliance. Anonymity and exclusively academic use of data were emphasized during participant briefing to mitigate response biases and address ethical concerns. These measures aimed to methodologically reduce common method variance through psychological assurance, and ethically uphold participants' privacy rights in line with research integrity standards. Statistical analyses were rigorously conducted to evaluate common method bias. Harman's single-factor test revealed that the first principal component accounted for 24.96 percent of total variance, substantially below the 50 percent threshold indicating potential bias. Furthermore, using the unmeasured latent method construct approach, we compared model fit indices between the baseline five-factor model ($\chi^2/df = 776.792/729 = 1.066$; RMSEA = 0.019; SRMR = 0.036; CFI = 0.993; TLI = 0.992) and a method-factor augmented model. The absence of significant improvement ($\Delta CFI < 0.002$) suggests that common method variance had little influence on the results. These methodological and statistical measures indicate that response bias was effectively controlled, and the data reliably reflect participants' authentic perceptions.

RESULTS

Descriptive statistics

Table 3 shows the means, standard deviations, correlations, and square roots of the AVE for the study variables. PES is significantly positively correlated with NPDP ($r = 0.416$, $p < 0.01$) and environmental collaboration ($r = 0.340$, $p < 0.01$). Environmental collaboration is significantly positively correlated with technological opportunism ($r = 0.636$, $p < 0.01$). Technological opportunism is significantly positively correlated with NPDP ($r = 0.674$, $p < 0.01$).

Table 3. Means, Standard Deviations, Correlations

Variables	M	SD	1	2	3	4	5	6	7	8	9
1. Type of new product	0.770	0.420									
2. Industrial type	0.850	0.361	-0.043								
3. Firm ownership	0.240	0.444	-0.068	0.092							
4. Competitive intensity	4.900	0.750	0.051	0.074	0.091						
5. PES	4.240	1.582	-0.145	-0.121	0.014	-0.037	0.807				

6. EC	3.47 0	1.31 1	- 0.060	-0.057	0.007	-0.069	0.340*	0.860			
7. TO	3.76 0	1.32 8	- 0.055	- 0.149*	0.- 063	-0.101	0.283*	0.636*	0.890		
8. NPDP	3.47 0	1.26 9	- 0.086	-0.111	- 0.092	-0.104	0.416*	0.696*	0.674*	0.862	
9. ORT	4.03 8	1.75 6	- 0.011	-0.103	- 0.025	-0.063	0.146	0.261*	0.120	0.451*	0.879

Notes: N = 176, **p<0.01, *p<0.05. Bold values at the diagonal are the square root of the average variance extracted (AVE) of the variables; off-diagonal values are correlations among variables.

Hypotheses tests

We used SPSS 23 and the PROCESS macro (Hayes, 2013) to test the hypothesized relationships in this study. PROCESS Model 6 was used to analyze the direct and sequential mediating roles of environmental collaboration and technological opportunism, and PROCESS Model 87 was used to analyze the moderating effect of organizational risk-taking tolerance in the research framework.

Table 4 shows the bootstrap results for the direct and indirect effects. Hypothesis 1, positing a positive effect of PES on NPDP, was supported ($\beta = 0.173$, 95 percent CI = [0.056, 0.222]). Hypothesis 2, which predicted a mediating effect of environmental collaboration on relationship between PES and NPDP, was supported by the results ($\beta = 0.110$, 95 percent CI = [0.057, 0.173]). However, hypothesis 3, suggesting mediation through technological opportunism, was not supported ($\beta = 0.018$, 95 percent CI = [-0.018, 0.062]). Hypothesis 4 predicting a positive effect of environmental collaboration on technological opportunism, was supported ($\beta = 0.605$, 95 percent CI = [0.488, 0.735]). Finally, Hypothesis 5, stating that PES indirectly affects NPDP sequentially through environmental collaboration and technological opportunism, was also supported with significant results ($\beta = 0.058$, 95 percent CI = [0.031, 0.093]).

Table 4. Bootstrap Analysis of the Direct and Indirect Effects of PES on New Product Development Performance

Effects	β	SE	CI	
			LLCI	ULCI
PES→NPDP (H1)	0.173	0.042	0.056	0.222
PES→EC→NPDP (H2)	0.110	0.030	0.057	0.173
PES→TO→NPDP (H3)	0.018	0.021	-0.018	0.062
EC→TO (H4)	0.605	0.063	0.488	0.735
PES→EC→TO→NPDP (H5)	0.058	0.016	0.031	0.093

Notes: N = 176, where PES = proactive environmental strategy; EC = environmental collaboration; TO = technological opportunism; NPDP = new product development performance; ORT = organizational risk-taking tolerance.

To test the moderating effect, we used PROCESS Model 87 with 5,000 bootstrap iterations (Hayes, 2013) and obtained the index of moderated mediation, which was significant (index = 0.009, 95 percent CI = [0.001, 0.020]). After using mean-centering (Figure 2), the plot of the interaction demonstrated that the association between technological opportunism and NPDP was more pronounced when organizational risk-taking tolerance was high (+1 SD; $\beta = 0.460$, $p < .001$) relative to when it was low (-1 SD; $\beta = 0.278$, $p < .001$). Thus, Hypothesis 6a was supported.

Figure 2. Interaction Plot for the Influence of Organizational Risk-Taking Tolerance on the Technological Opportunism–NPDP Relationship.

The results in Table 5 show that the indirect effect of PES on NPDP through environmental collaboration and technological opportunism was more positive (difference = 0.031, 95 percent CI = [0.002, 0.070]) when organizational risk-taking tolerance was high ($\beta = 0.047$, SE = 0.015, 95 percent CI = [0.022, 0.080]) than when it was low ($\beta = 0.078$, SE = 0.022, 95 percent CI = [0.042, 0.128]). Thus, Hypothesis 6b was supported.

Moderator		Effect	SE	95 percent CI
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Organizational risk-taking tolerance	Low Organizational risk-taking tolerance (Mean-1SD)	0.047	0.014	[0.022, 0.080]
	High Organizational risk-taking tolerance (Mean+1SD)	0.078	0.022	[0.042, 0.128]
	diff	0.031	0.017	[0.002, 0.070]

Notes: N = 176.

Robustness tests

First, we further examined the sequential mediation effects in this study using Mplus 7.0. The test results shows: The direct positive effect of PES on NPDP was significant ($\beta = 0.385$, $SE = 0.071$, $p < 0.001$); PES had a significant positive effect on environmental collaboration ($\beta = 0.640$, $SE = 0.049$, $p < 0.001$, 95 percent CI [0.538, 0.728]), while environmental collaboration showed a positive but insignificant effect on NPDP ($\beta = 0.074$, $SE = 0.071$, $p > 0.05$, 95 percent CI [-0.062, 0.219]). Consequently, the mediating effect of PES on NPDP through environmental collaboration was positive but non-significant, with a path coefficient of 0.047. PES demonstrated a significant positive effect on technological opportunism ($\beta = 0.372$, $SE = 0.061$, $p < 0.001$, 95 percent CI [0.253, 0.495]), and technological opportunism significantly positively influenced NPDP ($\beta = 0.333$, $SE = 0.073$, $p < 0.001$, 95 percent CI [0.181, 0.467]). Therefore, PES exerted a significant positive effect on NPDP through technological opportunism,

with a path coefficient of 0.124. Environmental collaboration significantly positively affected technological opportunism, indicating that environmental collaboration and technological opportunism sequentially mediated the positive relationship between PES and NPDP, with a combined path coefficient of 0.108. the research findings remained similar to the previous results.

Second, Zhang et al. (2024) argued enterprises in high-pollution industries face greater market access restrictions and higher pollution control costs under equivalent environmental regulation, thus exhibiting stronger incentives to adopt PES. To address this, we excluded SMEs in high-pollution industries and re-ran the model, obtaining consistent results. Additionally, we excluded firms in the top and bottom 5% of performance, and these robustness checks also aligned with the main findings.

DISCUSSION AND CONCLUSION

Discussion

This study examines how PES enhances NPDP in SMEs based on the RBV's resource–capability–performance framework. The results indicate that PES positively affects NPDP by enabling the integration of resources and reconfiguration of capabilities. Environmental collaboration acts as a significant mediator in this relationship, while technological opportunism shows no direct mediating effect. Consistent with prior research, PES' driving resource reallocation helps alleviate internal constraints and improve performance (Seroka-Stolka & Fijorek, 2020), supporting the assumption that resource-constrained SMEs hardly develop specific capabilities. Furthermore, a sequential mediation pathway is identified, in which PES promotes environmental collaboration, which boosts technological opportunism, ultimately facilitating NPDP. This highlights how SMEs use relational resources to overcome internal limitations and enhance their responsiveness to technological opportunities. Nevertheless, unlike some prior studies emphasizing technological opportunism as a standalone mediator, our findings reveal its dependence on prior environmental collaboration, reflecting the hierarchical nature of capability development in resource-constrained SMEs. The absence of a direct mediating effect of technological opportunism may stem from SMEs' inherent resource limitations when simultaneously pursuing innovation and environmental objectives, leading them to prioritize immediate gains from collaboration over long-term capability building. This divergence underscores the

challenges SMEs face in balancing dual objectives. Our study emphasizes environmental collaboration as a foundational step for realizing the performance benefits of PES, refining the RBV framework in sustainability-driven innovation contexts. Furthermore, the sequential mediation effect of environmental collaboration and technological opportunism between PES and NPDP is strengthened by organizational risk-taking tolerance, as technological opportunism more strongly enhances NPDP when risk tolerance is higher. This indicates that resource efficacy is contingent on organizational context, offering new insights into how SMEs can simultaneously pursue sustainability and innovation despite resource constraints.

6.2 Theoretical contributions

Comprehensive green transformation of economic and social development has created immense opportunities and challenges for enterprises. We explored the unexpected outcome of PES in SMEs, and our findings contribute to the literature theoretically in several ways.

Firstly, our study enriches the literature on PES with the advancement of the current understanding of its outcomes. Existing studies have demonstrated the positive effects of PES on market performance (Nguyen & Adomako, 2021), firm performance (Li et al., 2022), and environmental performance (Mustafa et al., 2022), neglecting NPDP. Some scholars have argued that developing novel and high-quality new products may

not align with sustainability because of their high investment and energy consumption (Hengst et al., 2020). However, this view ignores that new technologies can be an innovation source in product development to meet customers' demand in terms of products' basic functional attributes (Mariani & Dwivedi, 2024). Product stewardship is an important component of PES. PES not only guides enterprises to develop energy-saving and consumption-reducing products but also aims to gain a new competitive edge through products (Aragón-Correa & Rubio-López, 2007). We aimed to fill this research gap by examining the effects of PES on NPDP based on the definition of new products and essence of NPD. Our results demonstrate the positive relationship and transform the stereotype of the paradox between PES and new products with high quality and novelty by identifying a strong link between PES and technological advancement. Furthermore, we showed that PES serves as not only an important initiative for enterprises to realize green transformation and sustainable development but also an effective competitive strategy to increase economic revenue and maintain long-term advantages in a new round of market competition.

Secondly, we theoretically clarify the underlying mechanism of how PES promote NPDP in SMEs by identifying the core roles of environmental collaboration and technological opportunism, which allows for a new path to use advanced technologies to develop high-quality novel products. We found that environmental collaboration, as relational resource, is a necessity that creates a bridge between PES and technological opportunism for SMEs which is featured with constrained internal resources. We cannot expect a sense-response capability to new technologies without environmental collaboration, let alone NPDP driven by new technologies in SMEs. Therefore, environmental collaboration not only acts as a supplementary resource for SMEs but also a key source of the sense-response capability for new technologies, which offers opportunities to improve NPDP. Previous studies regarded environmental collaboration as an organizational resource that can directly promote innovation and performance (Kulangara et al., 2022), overlooking the effect of environmental collaboration on organizational capabilities. This may limit a comprehensive understanding of resources and capabilities under the RBV (Helfat et al., 2023), particularly with respect to building internal capabilities through external resources. The results of this study also help explain the interactive mechanism by which environmental collaboration triggers technological opportunism and highlight the role of resources in developing organizational capabilities. Further, with the RBV's resource–capability–performance framework, we developed and tested a process model to examine the sequential mediating roles of environmental collaboration and technological opportunism in the relationship between PES and NPDP in SMEs. The findings not only fill the research gap discussed above but also respond to the call for from some scholars to separate resources and capabilities within the RBV

framework to clarify whether capabilities are an important platform for the effective utilization of relational resources (Gölgeci et al., 2019).

Thirdly, our findings help extend the understanding about when and how technological opportunism works. Inconsistent results have been shown in previous studies on the relationship between technological opportunism and performance because of different boundary conditions (Chen & Lien, 2013; Urban & Maphumulo, 2021). Enterprises' temporal orientation will affect its effectiveness, as technological opportunism is a future-oriented capability (Srinivasan et al., 2002). For example, with high level of market orientation, enterprise's focus on current market demand weakens the positive relationship between technological opportunism and performance, while high level of technological uncertainty will strengthen the positive effect of technological opportunism on performance (Chen & Lien, 2013), as high level of technological uncertainty imply rapid technological development (Bstieler, 2005).

Finally, this study provides a deeper comprehension of organizational context factors for successful PES' implementation by integrating organizational risk-taking tolerance as organizational climate in the empirical study of PES. As a pioneering exploration of organizational risk-taking tolerance in PES, our findings underscore the role of organizational risk-taking tolerance as a firm-specific context in environmentally relevant activities, responding to recent calls by Alcalde-Heras and Carrillo (2025) and (Bechtel et al., 2025) for deeper investigation into the interdependence between strategic and organizational dimensions in advancing sustainability. Meanwhile, organizational risk-taking tolerance, a firm-specific context, aligns with the inherent risk nature of PES and NPD (Aragon-Correa & Sharma, 2003; Urbig et al., 2011), allowing more trial-and-error and risk-taking, and benefit for an enterprises' achievement, which indicates the pivotal role of firm-specific context in environmental activities reinforcing RBV's contingent principles.

Practical implications

This study's results have several practical implications. First, SMEs' managers are suspicious of the economic benefit of environmental management and are reluctant to pay attention to environmental issues because of the extra resources required. However, our findings highlight the positive role of PES in SMEs. PES helps SMEs fulfill their environmental responsibilities, develop organizational capabilities, and promote green transformation to achieve unique competitive advantages. Therefore, we encourage SMEs managers to have a positive attitude towards environmental management, take the initiative to assume environmental responsibilities, and gain legitimacy and market advantages in the new field of competition. Meanwhile, SMEs managers also need to attach sufficient importance to the search, identification, and utilization of external resources overcome resource constraints for SMEs in implementing PES. This study's results indicate that environmental collaboration is an

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important supplementary resource. SMEs can obtain relational rents when they cooperate and interact with their suppliers to achieve a common environmental vision using a shared resource pool. Accordingly, managers need to search for and recognize potential suppliers and establish close contact with those qualified with advanced environmental production and governance; form mechanisms to share environmental data among departments to build consensus on environmental protection; and build management performance evaluation systems with environmental indicators to strengthen internal green integration, influence suppliers' green integration, share environmental data with suppliers, and conduct joint monitoring and collaborative improvement.

Secondly, managers should focus on key factors for firm performance. Our findings indicate that technological opportunism is the core capability in the relationship between PES and NPDP, and is triggered by collaborative relationships with suppliers. We suggest that focal enterprises actively interact and communicate with collaborative organizations or institutions; frequently reflect on environmental goals, strategic practices, and processes to examine their own possible gaps; and enhance their sensitivity to new knowledge and technologies. Thus, they can become acquainted with new technological trends and respond to potential applications in a timely manner. They should also cultivate an open and compatible organizational culture and encourage managers and employees to actively participate in various expos and industrial forums to broaden their technological horizons and promote cross-border learning. However, not all types of opportunism are beneficial for collaborative relationships. Focal enterprises should not engage in negative opportunistic behaviors that undermine long-term commitments with collaborative partners.

Finally, managers should note the contingent factors affecting PES efficacy, such as organizational risk-taking tolerance. Specifically, enterprises should embrace risk-taking in innovation and R&D, yet excessive risk may threaten survival. Thus, a balance is essential to maintain appropriate risk tolerance, enabling aggressive innovation while safeguarding sustainable development.

7 Potential Limitations and Future Research Directions
Besides theoretical contributions, this study has several limitations that have implications for further research. Due to limited existing literature, we focused on SMEs and identified environmental collaboration as a key relational resource for alleviating resource constraints. Besides suppliers, other stakeholders such as local governments and consumers also closely interact with SMEs. Future research should explore additional relational resources to better understand how SMEs address resource constraints in PES implementation. This study assumed a linear effect of PES on NPDP in SMEs, yet nonlinear or negative relationships may exist (Li et al., 2022). Future studies could use other variables to examine different statistical relationships and enrich

the current understanding of PES implementation in SMEs. Although organizational risk-taking tolerance was examined as a moderating variable based on RBV, other organizational characteristics, for example, collective efficacy (Tao et al., 2024) and external environmental factors, like government support (Li et al., 2022) that are important to SMEs also affect the relationship between PES and firm-level performance. Future work should investigate these potential contingencies.

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Disclosure statement

The authors report there are no competing interests to declare.

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