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Impact of eco-embeddedness and strategic flexibility on innovation performance of non-core firms: The perspective of ecological legitimacy

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ABSTRACT

For non-core firms, the key to achieving innovation performance and building sustainable competitive advantage is accessing innovation resources and strengthening capabilities through eco-embeddedness. Based on innovation ecosystem theory, this study empirically explores the impact of innovation eco-embeddedness on the innovation performance of non-core firms and the mechanisms of strategic flexibility and ecological legitimacy among them. Using questionnaire data from 354 ecological non-core firms in China, the research results demonstrate that both eco-embeddedness position and eco-embeddedness relation have significant positive effects on the innovation performance of non-core enterprises. Furthermore, strategic flexibility partially mediates the relationship among the eco-embeddedness position, eco-embeddedness relation, and innovation performance of non-core firms. Moreover, ecological legitimacy plays a positive moderating role in the eco-embeddedness position and eco-embeddedness relation, promoting the strategic flexibility of non-core companies. This study contributes a non-core perspective to ecosystem research by revealing the complex process mechanism of innovation performance enhancement in ecological non-core firms and provides a theoretical basis and practical guidance for how Chinese firms can leverage innovation eco-embeddedness to promote innovation and realize growth.

Introduction

The exogenous nature of China's strategic opportunities is diminishing due to the increasingly challenging international situation and competitive dynamics, especially the intensifying trade frictions between China and the United States and the COVID-19 pandemic. Moreover, how Chinese firms achieve innovation has become key to their survival and development (Zheng & Wang, 2020). Since Chinese firms cannot innovate independently, it is difficult for them to cope with the increasingly dynamic competitive environment with their resources and capabilities (Mei & Zhang, 2022). Accordingly, many enterprises attempt to establish different innovation collaboration methods with external organizations, increasing the number of partners in innovation ecosystems as a competitive strategy (Wei, et al, 2021). An innovation ecosystem is a synergistic, symbiotic, and dynamically coordinated system composed of interdependent stakeholders. As a new organizational cooperation structure, it has significant advantages, such as multi-organizational symbiosis, resource complementation, value co-creation, and co-evolution, which provides a habitat for enterprises to gain competitive advantages and co-resist innovation risks (Adner, 2017; Xu et al., 2018).

Accenture's January 2018 survey of 1252 leaders of businesses with revenue over $1 billion across 13 industries worldwide revealed that 60 percent of executives would like to "build ecosystems" to transform industries or lead disruptions. The focal firms in the core position gather the resources of different participants by establishing ecosystems to achieve value co-creation and thus promote industry change. Leading companies such as Apple, IBM, and Google have built such ecosystems to attract many players, hence creating influential and disruptive innovations and gaining new user values and competitive advantages in the market (Moore, 1993; Iansiti & Levien, 2004). Similarly, the ecosystem participants can also acquire complementary resources such as assets, technologies, and markets suitable for their development by embedding themselves into the ecosystem and collaborating to expand their capabilities (Mei et al., 2019). For instance, Spotify on Apple's iOS platform, SDK providers on Google's Android platform, and other ecological non-core companies participate in building systems to develop products and services, increasing complementarity and creating value for the ecosystem. They also enhance their competitiveness and sustainability to deliver superior performance. (Kapoor & Agarwal, 2017; Hukal et al., 2020; Reisinger et al., 2021).

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The management practice of innovation ecosystems is increasing with many disruptive developments and has stimulated many scholars' research interests, resulting in promising theoretical results. Existing studies have conducted in-depth research based on different perspectives around the concept and composition of innovation ecosystems (Iansiti & Levien, 2004), internal governance mechanisms (Selander et al., 2013), evolutionary dynamics (Gans & Ryall, 2017), and the like. For example, based on a value co-creation theory perspective, some scholars have delved into how component challenges and complement challenges in innovation ecosystems enhance or undermine the competitive advantage of core firms in terms of technological leadership, resulting in interdependent relationships for the co-creation of value (Adner & Kapoor, 2010). From the competitive theory perspective, some researchers have used several ecosystem cases within the solar industry as research samples and pointed out that system network relationships have long gone beyond superficial bilateral relationships. As dominant firms enter new ecological segments, they are more inclined to adopt co-opetition balance strategies to achieve success (Hannah & Eisenhardt, 2018).

From the viewpoint of co-evolutionary theory, some academics have employed the business ecosystem of the computer industry to reveal the nature of the co-evolutionary process and its impact on complex product innovation, indicating that the evolutionary process includes three areas: shared vision, co-design, and co-creation (Liu & Rong, 2015). The innovation ecosystem is still an emerging research area, and the existing literature is primarily case studies exploring the mechanisms core firms use to promote ecosystem construction and value co-creation for competitive advantage. However, empirical research on innovation ecosystems is lacking, especially about how non-core firms can achieve innovation and development through such ecosystems. Non-core firms are the participants in the ecosystem that engage in value creation activities around the focal firm or platform, playing an indispensable role in the functional complementation with core firms and improvement of the ecosystem. Consequently, it is important to investigate the underlying mechanism of how non-core firms embed themselves into the ecosystem to improve performance and what contingency factors affect them, which will help extend and enrich the innovation ecosystem theory from an ecological non-core perspective.

Researchers have also demonstrated that embedded companies in non-core positions differ significantly in resource search and acquisition and strategic choices in the innovation ecosystem due to their disparate positions (Kapoor & Agarwal, 2017; Zhu & Liu, 2018). Moreover, how efficiently ecosystem resources are utilized to strengthen their capabilities is crucial for the survival and growth of non-core firms. As a critical corporate capability, strategic flexibility improves environmental adaptability and competitiveness, helps self-iteration and performance growth (Zhou & Wu, 2009), and creates opportunities for non-core enterprises to transform development strategies and achieve resource integration. Thus, non-core firms must build strategic flexibility to translate ecological advantages into organizational performance.

Additionally, the institutional theory states that corporate activities are deeply nested in a specific institutional environment, and external institutional support provides an essential foundation for firm survival and development (Li & Atuahene-Gima, 2001). Since non-core firms are in a complex and diverse ecosystem, gaining ecological legitimacy is essential to win stakeholders' recognition and improve their ecological status. Therefore, they should integrate into the system to achieve value co-creation. Above all, it is necessary to analyze realization paths that non-core firms can use strategic flexibility to absorb and integrate ecological resources and the effect of ecological legitimacy on the ability of non-core companies to overcome the "new entry defect" (Stinchcombe, 2000) and achieve survival and growth. Research on these topics will support and promote the theory and practical application of the innovation eco-embeddedness of corporate.

Drawing upon the above, this study explores the relationship between innovation eco-embeddedness and innovation performance of non-core firms based on innovation ecosystem theory, strategic flexibility theory, and institutional theory. It examines the mediating role of strategic flexibility and the moderating role of ecological legitimacy. This study tries to open the "black box" of the intermediate mechanism of eco-embeddedness that affects the innovation performance of non-core enterprises and explore the boundary conditions of eco-embeddedness affecting strategic flexibility. It provides a theoretical basis and management inspiration for Chinese firms to implement innovation eco-embeddedness in practice.

Literature review and research hypothesis

Innovation eco-embeddedness and innovation performance

An innovation ecosystem is a dynamic coordination structure composed of different participating actors pursuing a joint value proposition for mutual benefit, symbiosis, and synergistic evolution (Adner, 2006), emphasizing the integration of resources and complementary advantages among stakeholders across organizational boundaries. By establishing cooperative and trustworthy interdependent linkages, ecosystem members achieve value co-creation and value sharing, promoting coordinated development and co-evolution (Adner & Kapoor, 2010; de Vasconcelos Gomes et al., 2018). Based on innovation ecosystem theory and non-core firm perspective, this study defines innovation eco-embeddedness as a paradigm in which ecological non-core enterprises embed themselves in an open and cooperative innovation ecosystem (Mei et al., 2019). By occupying an ecological niche suitable for firm development and building a close ecological cooperation relationship, they obtain rich ecological innovation resources and realize complementary collaboration. Thus, innovation eco-embeddedness provides a solid resource base and sufficient innovation power for corporate innovation.

According to the specific ecosystem location and the interaction characteristics with other stakeholders, innovation eco-embeddedness can be divided into the eco-embeddedness position and eco-embeddedness relation. The eco-embeddedness position refers to the network position occupied by the non-core firm in the ecosystem, reflecting the varieties of resources or channels the non-core firm can access. The eco-embeddedness relation is the complementary relationship between the non-core firm and other players in the innovation collaboration, describing the complementarity and availability of resources and capabilities among ecological cooperative enterprises. An in-depth study of these two dimensions can provide a more comprehensive picture of the characteristics and effects of non-core companies' innovation eco-embeddedness behavior.

For the eco-embeddedness position, the broader the non-core firms occupying the ecological niche, the more favorable their network location, indicating the richer variety and quantity of external resources the firms can access. Therefore, the non-core firm is closer to the "generalist" (Freeman & Hannan, 1983). First, unique and hard-to-imitate critical resources are sources for enterprises to maintain sustainable competitiveness. Non-core enterprises with higher eco-embeddedness position can access rich innovation knowledge and technological resources, especially heterogeneous resources of ecological partners. These advantages enhance the freshness and breadth of internal resources and facilitate the bursting of new ideas and knowledge. Thus, it complements the internal research and development (R&D) and promotes the innovative activities of non-core enterprises (Zhou & Li, 2012).

Second, the network position affects firms' access to innovation resources (Yan et al., 2020). A favorable eco-embeddedness position indicates that the non-core firm is closer to the ecosystem's center.

Therefore, such firms have more robust system adaptability and stability (Shipilov, 2006) and a more extensive range of innovation sources. By establishing ties with diverse ecological partners such as suppliers and users, non-core enterprises can improve their perception and control of the external environment. Additionally, it helps non-core companies expand the breadth and channels of knowledge search and information storage and gain a more comprehensive understanding of technological frontier trends and user demand trends, which is valuable for sharing innovation costs and risks. Thus, the eco-embeddedness position will help non-core firms achieve valuable innovation outputs (Wynarczyk et al., 2013).

For the eco-embeddedness relation, while occupying a strong innovation eco-embeddedness position provides an important way for corporations to access rich innovation resources, what non-core firms can harvest from external resources depends more on the extent to which resources and capabilities are complementary among eco-firms (Mei & Zhang, 2021). Moreover, the critical motivation for firms to embed in innovation ecosystems is to build deep partnerships and achieve collaborative innovation with complementors (Wei, et al, 2021). A complementary relationship increases the availability of the resource capabilities of ecological partners and supports non-core enterprises to combine complementary resources more effectively with internal resources. Thus, it allows non-core companies to create new combinatorial quantities and synergistic values that facilitate the transfer and absorption of innovation and contributes to innovation performance (Bianchi et al., 2014; Foerderer, 2020; Mei & Zhang, 2021).

Ecological partners have similar value bases and technological backgrounds, which means that the knowledge distance between ecological cooperation members is shorter, and the cognitive structure and practices converge. All of these are conducive to deepening non-core enterprises' knowledge and understanding of each other's resources, increasing the frequency of interaction and transformation combination between the two sides, and improving the efficiency of absorbing and utilizing external knowledge. Meanwhile, non-core firms can also utilize this opportunity to introduce and utilize relevant technical talents, reduce the cost of learning new knowledge, and improve learning efficiency, thus facilitating innovation performance (Wynarczyk et al., 2013).

However, homogeneous resources help accelerate knowledge uptake but tend to lead to resource redundancy and novelty deficiency. In contrast, the available heterogeneous resources brought by complementary relationships are conducive to empowering innovation and facilitating knowledge acquisition and reorganization in non-core companies. Furthermore, the heterogeneous resources that fit with each other will compensate for the knowledge deficit of non-core enterprises and meet the innovation needs of both parties (Huang et al., 2015). This is conducive to enhancing exploratory learning, generating new ideas and iterative solutions, and forging innovation paths and models, which increase innovation success and accelerate the commercialization process of innovation (Fuentelsaz et al., 2015). Therefore, this study proposes the following hypotheses:

H1: There is a positive relationship between the eco-embeddedness position and innovation performance of non-core firms.
H2: There is a positive relationship between the eco-embeddedness relation and innovation performance of non-core firms.

Mediating role of strategic flexibility

Given the increasingly severe technological challenges and volatile external environment, innovation eco-embeddedness facilitates enterprises in expanding their resource pool and establishing eco-collaboration. Due to the static nature of resources, how the external resources acquired by eco-embeddedness are transformed into innovation output depends on the capability of non-core firms. It is the capacity variance that is an important factor affecting the difference in firms' innovation performance. Furthermore, dynamic capability theory expands the static perspective of the resource-based view and overcomes the shortcomings of core rigidity, which emphasizes the importance of corporations establishing dynamic capabilities to integrate, construct, and reconfigure resources to gain a sustained competitive advantage (Eisenhardt & Martin, 2000; Teece, 2009; Chesbrough et al., 2021). Strategic flexibility, as a concrete expression of dynamic capabilities, is a manifestation of the firms' flexibility and diversity (Chen et al., 2017; Brozovic, 2018) and helps non-core companies mobilize and reconfigure resources quickly in response to external changes, break organizational practices, and change in time to meet environmental requirements better, thus advancing their innovative activities (Li et al., 2017; Brozovic, 2018). Consequently, this study infers that strategic flexibility assumes an intermediate bridging role between innovation eco-embeddedness and innovation performance.

A superior eco-embeddedness position illustrates that the richer the heterogeneous resources, the wider the ecological subjects non-core firms connect, which allows them to access more non-duplicative or non-redundant resources (Lunnan & Haugland, 2008), effectively alleviating the dilemma of resource interactions in different technological fields (Chiang & Hung, 2010). Further, it expands the range of resources available to firms, alleviating firms' resource needs when managing complex environmental changes and creating a foundation for non-core enterprises to build strategic flexibility (Brozovic, 2018; Yawson, 2020). Simultaneously, frequent interaction with different eco-members facilitates non-core firms to search and acquire external information and knowledge more comprehensively (Zhou & Wu, 2009; Chan et al., 2017) and perceive stakeholder needs and environmental changes more sensitively. This motivates non-core companies to shape strategic flexibility by assisting them in adjusting organizational processes and resource allocation schemes appropriately (Dentoni et al., 2015). Generally, adequate resource security and extensive searches for external information enable corporations to cope with possible uncertainties, reduce the risk of insufficient resources for innovation activities, and adapt better to changes in market demand. Therefore, it provides a solid guarantee for non-core firms' innovation activities and contributes to innovation performance (Li et al., 2017; Miroshnychenko et al., 2021).

Additionally, the highly complementary relationship between non-core enterprises and eco-partners improves the availability of external resources and reduces confusion in the cognitive process, facilitating the transfer of tacit knowledge across organizational boundaries. This stimulates non-core firms to transfer the resource capabilities of eco-partners, which they can use faster and with less difficulty. Hence, the eco-embeddedness relation lowers technological barriers and expands the knowledge base of non-core enterprises, enriching the possibilities and boosting innovative solutions (Zhou & Wu, 2009; Li et al., 2017). Meanwhile, the effective matching and compatibility of resource capabilities enhance mutual trust and relationship quality among members and improves firms' insights into the characteristics of shared resources and capabilities (Fuentelsaz et al., 2015). This facilitates non-core firms to absorb and utilize external resources efficiently and explore innovative uses and new combinations of ecological resources collaboratively.

Accordingly, non-core companies are supported to create more excellent innovation value through proactive and rationalized innovation in response to changing market demands and environmental changes (Zhou & Wu, 2009; Liu et al., 2013). Thus, strategic flexibility permits non-core firms to combine complementary resources and innovation quickly (Wei et al., 2014; Miroshnychenko et al., 2021) and improve opportunity identification and assessment. Hence, non-core enterprises can integrate ecological resources to carry out innovation activities and improve innovation performance (Chan et al.,

2017; Li et al., 2017). Based on the analysis above, the following hypotheses were formulated:

H3: Strategic flexibility has a mediating role between eco-embeddedness position and innovation performance of non-core firms.
H4: Strategic flexibility has a mediating role between eco-embeddedness relation and innovation performance of non-core firms.

Moderating role of ecological legitimacy

As an essential element of strategic management and institutional theory, ecological legitimacy provides vital support for corporations in sustaining access to external innovation resources and gaining stakeholder support, playing an alternative motivational role in resource acquisition (Zimmerman & Zeitz, 2002). This is defined as the generalized perception that an organization's actions or the values hidden behind them are appropriate, desirable, and suitable according to social evaluation criteria and in line with expectations (Suchman, 1995). Ecological legitimacy includes evaluations by external agents and reflects the degree to which the enterprise is recognized or accepted by the external environment and institutional context.

There are many diverse and complex ecological agents in the innovation ecosystem. The success rate of eco-embeddedness and the efficiency of access to resources are determined by whether stakeholders recognize the non-core company and whether it conforms to the ecological value vision and public perception (Thomas & Ritala, 2021). Furthermore, if a non-core enterprise's innovation does not lead to innovation or improvement of complementary elements in the eco-partnership, and if it does not gain the recognition of the partner, then its innovation will not be supported. Even worse, if the non-core enterprise is recognized as illegitimate, it is likely to be resisted and rejected by the whole ecosystem and eventually lose its ecological collaborator status (Adner & Kapoor, 2010; Kuratko et al., 2017; Chesbrough et al., 2021). Consequently, gaining ecological legitimacy is essential for non-core firms to adapt to the ecosystem's environment and rules and improve the efficiency of utilizing resources and capabilities.

Focusing on the eco-embeddedness position, non-core firms may obtain network "spillover" and "ride back" effects by establishing relationships with and receiving support from reputable players in the system, especially focal firms (Suchman, 1995; Zimmerman & Zeitz, 2002), which may help enhance innovation capabilities. Moreover, the recognition of non-core enterprises by various eco-partners and the value fit with the ecosystem increases strategic coherence, making the firm's activities more readily accepted and understood by all eco-partners and increasing the possibility of establishing multi-partnerships (Zhou et al., 2014). This broadens the channels of innovation resources that corporations hunt for and provides necessary guarantees for non-core firms to access information and heterogeneous resources such as raw materials, customer needs, and national policies (Thomas & Ritala, 2021). Additionally, ecological legitimacy allows non-core enterprises to broaden the available resources and improve the variety of resource portfolios and resource allocation efficiency, thus building better strategic flexibility to meet innovation challenges (Sheng et al., 2011).

Focusing on eco-embeddedness relation, ecological partners with complementary relationships provide practical and innovative value to non-core enterprises. Therefore, non-core firms must pay special attention to partnerships with complementors, actively increase trust and communication, and meet stakeholders' expectations. In this way, non-core companies may acquire valuable resources and information and create opportunities for collaborative innovation (Zhou et al., 2014). Furthermore, a high level of support and trust from complementors permits non-core companies to understand the current system's existing norms, allowing them to integrate better into the system to co-create value (Walrave et al., 2018; Thomas & Ritala, 2021). Simultaneously, the recognition of eco-complementor enhances the understanding and utilization of both parties' knowledge by non-core firms, which promotes the efficient use of knowledge and information sharing between corporations. This enables non-core enterprises to absorb and integrate resource capabilities efficiently, develop potential utilization solutions and beneficial complementary combinations according to external changes, and optimize organizational processes and structures. In this way, ecological legitimacy strengthens the strategic flexibility of non-core firms (Autio et al., 2014; Foerderer, 2020). Subsequently, the following research hypotheses were proposed:

H5: Ecological legitimacy enhances the positive impact of eco-embeddedness position on strategic flexibility of non-core firms.
H6: Ecological legitimacy enhances the positive impact of eco-embeddedness relation on strategic flexibility of non-core firms.

Fig. 1 shows the theoretical framework of this study.

Research design

Sample and data collection

The data were obtained mainly through a questionnaire research method. We selected 20 non-core companies within a few local ecosystems, such as COSMOPlat and Xiaomi Eco-System, for a pre-survey

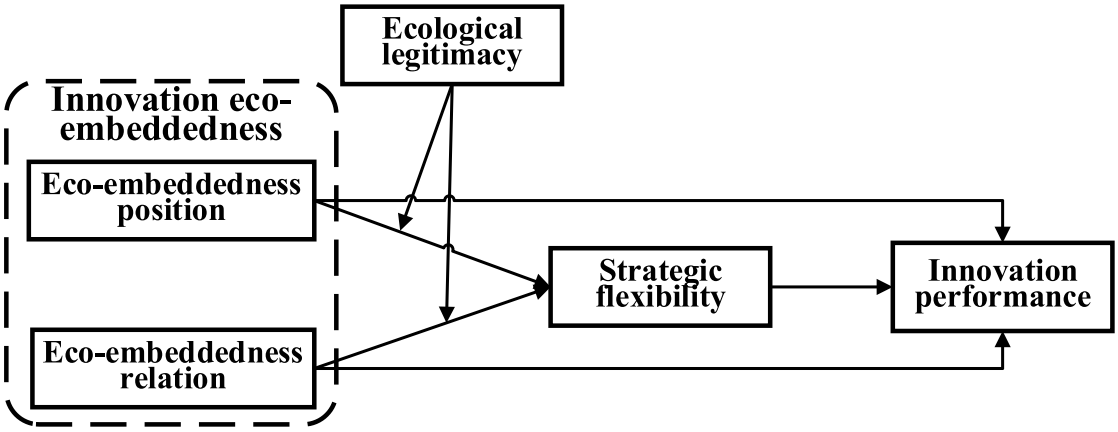

Fig. 1. Theoretical framework of this study.

through personal network connections. Based on the interviews and feedback results, the final questionnaire was modified with the advice of relevant experts. To improve the quality of the sample data, certain controls were exercised in sample selection. First, to ensure that the research objects are non-core firms in the ecosystem. Two screening questions, "Are you in the ecosystem dominated by focal or platform firms" and "Are you a non-core firm," were set to make the sample representative. Second, we set the item "R&D intensity" to measure the technological R&D and product service innovation activities of the sample subjects, most of which are knowledge-intensive and active in innovation, making the sample typical. Third, this study selects as many different types of innovation ecosystems as possible based on the convenience of data collection, and thus sets the question "industry type" to increase the diversity of the sample. The main characteristics of the non-core firms selected in this study are that they have resource constraints, relatively weak independent innovation capability, and prefer to embed into ecosystems to seek resources, information, and capabilities to achieve complementary advantages and collaborative innovation.

The formal research period was from June 2021 to December 2021, and the research subjects are non-core enterprises within several innovation ecosystems in China. The questionnaire was mainly completed by middle and senior managers who are familiar with corporate information. Given the current occurrence of the COVID-19 pandemic in China in the formal research phase, we collected the data mainly through two channels: professional research companies and important corporate contacts. The questionnaires were distributed using online links, emails, and other online forms through corporate WeChat groups, corporate emails, and personal contacts. As a result, 399 questionnaires were recovered, and 354 were finally valid after eliminating unqualified questionnaires with missing values and invalid questionnaires that were not "non-core firms." The basic information statistics of the sample are presented in Table 1.

Variables

To ensure the representativeness, validity, and fit of the sample, most of the scales in this study were selected from established and widely accepted scales. Additionally, we consulted relevant experts and scholars to make appropriate corrections and exclusions to determine the final content of the questionnaire, making it more suitable for the Chinese context. The original questionnaire was developed in English, then translated into Chinese for easier reading and completion, and finally retranslated back into English to ensure consistency in semantics across cultures. Unless otherwise stated, all questions were scored on a 7-point Likert scale, ranging from 1= "strongly disagree" to 7= "strongly agree," with increasing middle numbers representing a deepening level of agreement.

Table 1
Statistical characteristics of the sample information.

Categories	Items	Number of samples	Percentage (%)
Firm age	5 years or less	113	31.9
	6–10 years	114	32.2
	11–15 years	73	20.6
	16–20 years	47	13.3
	More than 20 years	7	2.0
Annual turnover	1 million or less	29	8.2
	1.01–10 million	123	34.7
	10.01–50 million	102	28.8
	50.01–100 million	65	18.4
	More than 100 million	35	9.9
Industry type	Traditional manufacturing	39	11.0
	Service industry	113	31.9
	Strategic emerging industry	156	44.1
	Other industry	46	13.0
R&D intensity	Less than 3%	7	2.0
	3–5%	119	33.6
	6–10%	154	43.5
	11–15%	53	15.0
	More than 15%	21	5.9

Note: N=354

The dependent variable was firm innovation performance. Due to the great complexity, uncertainty, and diversity of innovation outcomes, there is no unified system of measurement indicators for measuring innovation performance. Currently, there are two primary measurement approaches: the first uses objective indicators such as patents and product innovation (Sorenson & Fleming, 2004), and the second uses established scales to obtain subjective data (Laursen & Salter, 2006; Zeng et al., 2010). Given that firm innovation activities in emerging economies such as China are difficult to quantify through patent applications, this study refers to the maturity scales developed by Jiao et al. (2015), Hogan and Coote (2014) and administers four questions to measure firm innovation performance from the angle of financials and markets. Additionally, we select new product innovation (Zhang & Li, 2010) as a proxy variable for robustness testing.

The independent variable was innovation eco-embeddedness, which indicates that non-core enterprises are embedded into an open and cooperative innovation ecosystem constituted by many participating subjects to achieve collaborative innovation by establishing trusting, interactive, and symbiotic partnerships to share resources and complement each other's advantages. This study draws on the research methods of Laursen and Salter (2006), Granovetter (2008), Lunnan and Haugland (2008), and Huang et al. (2015) to measure eco-embeddedness position and eco-embeddedness relation using five measurement questions each. The former reflects the number and types of resources of the ecosystem members, which the non-core companies can attach, and the latter embodies the compatibility and complementarity of resource capabilities between non-core firms and ecosystem partners.

The mediating variable was strategic flexibility. Based on the definition and classification by Sanchez (1995) and (Wei et al., 2014), we devised eight questions to measure strategic flexibility from the applicability of corporate resources, the cost of switching, the organization's ability to identify external opportunities, and the resource allocation capabilities.

The moderating variable was ecological legitimacy, which mirrors the conformity of a corporation's activities to the structural expectations of society, especially in innovation ecosystems where the behavior and philosophy of non-core firms needs to maintain convergence with the overall ecosystem and gain widespread recognition and acceptance by different ecological partners. This study draws on the research scales of Suchman (1995) and Scott (2008), with some modifications and deletions based on expert suggestions, finally selecting four questions for measurement.

For the control variables, we referred to findings by Nasr et al. (2015) and Caner et al. (2017) that demonstrated that the enterprise's age, annual turnover, and industry type might affect the firm's innovation performance and the construction of strategic flexibility to some extent. Additionally, the corporate's R&D capabilities may influence the innovation outcome brought about by external cooperation, which helps the company absorb external resources to enhance innovation performance better (Cohen & Levinthal, 1990). Accordingly, we selected firm age, annual turnover, industry, and R&D intensity as the control variables. The specific definitions of the model variables are illustrated in Table 2.

Addressing common method variance

This study used the single-factor test proposed by Harman (1976) to test whether there was a homogeneous variance problem. The

Table 2
Variable definition.

Variable	Symbols	Definition	Studies
Dependent variable	InnPer (ProInn)	Innovation performance (Product innovation as a robustness test tool)	Hogan and Coote (2014); Jiao et al. (2015) Zhang and Li (2010)
Independent variable	EcoPos	Eco-embeddedness position	Laursen and Salter (2006); Granovetter (2008); Lunnan and Haugland (2008); Huang et al. (2015)
	EcoRel	Eco-embeddedness relation	
Mediating variable	StrFle	Strategic flexibility	Sanchez (1995); Wei et al. (2014)
Moderating variable	EcoLeg	Ecologic legitimacy	Suchman (1995); Scott (2008)
Control variable	Age	The age of the firm	Cohen and Levinthal (1990); Nasr et al. (2015); Caner et al. (2017)
	AnnTurn	Annual Turnover	
	Industry	Industry type	
	R&D	R&D Intensity	

results demonstrate that the proportion of variance explained by the first principal component is 30.297%, which meets the requirement of less than 40% and does not exceed 50% of the total explained variance of 62.519%, indicating that there is no homogenous severe variance problem in this study.

Reliability and validity tests

The reliability and validity of the scales were analyzed using SPSS 24.0. We selected Cronbach's α and composite reliability (CR) to test the reliability of the scale, and utilized exploratory and validation factor analyses to test the scale's validity. The results are presented in Table 3. As Table 3 illustrates, the Cronbach's α coefficients of all variables and the CR both are above 0.8, illustrating that the measurement model has high internal consistency and can deliver the sample situation stably and consistently. The factor loading values of all research questions were above 0.6, indicating that the measurement questions had good convergent validity. The results of the validated factor fit indicators are displayed in Table 4. The five-factor is superior to the other factor models (χ^2/Df=2.119, RMSEA=0.056,

Table 3
Results of reliability and validity analyses.

Variables	Items	Factor loading	AVE	CR	Cronbach's Alpha
Eco-embeddedness position	1. Our firm has established cooperation with many ecological partners;	0.805	0.606	0.884	0.882
	2. Our firm has acquired many kinds of resources in cooperation with ecological partners;	0.839			
	3. Our firm has launched many new products in cooperation with ecological partners;	0.795			
	4. Our firm and ecological partners carry out innovative cooperation in various modes (such as technology licensing and cooperative R&D);	0.792			
	5. The innovation cooperation between our firm and ecological partners is relatively frequent.	0.647			
Eco-embeddedness relation	1. The business type of our firm and ecological partner is similar and in the same industry field;	0.795	0.612	0.888	0.887
	2. The knowledge, technology, and resources of the ecological partner have high availability for our firm;	0.789			
	3. The combination of our resource capabilities and the ecological partners helps improve our firm's performance;	0.825			
	4. The combination of our resource capabilities and the ecological partners helps improve the performance of the ecological partner;	0.744			
	5. Our company has established a high level of cooperation and trust with our ecological partners.	0.757			
Strategic flexibility	1. The degree of sharing the same resources among each unit is high;	0.808	0.570	0.914	0.850
	2. The extent of the same resources used in developing, producing, and selling different products or services is high;	0.794			
	3. The cost and difficulty of switching the use of key resources to an alternative one is very low;	0.701			
	4. The time of switching the use of key resources to an alternative one is very short;	0.788			
	5. Our firm allows each unit to break normal procedures to maintain flexibility and dynamics;	0.756			
	6. Our firm's management style can be adapted to different people and situations;	0.719			
	7. Our firm has a very smooth communication mechanism;	0.733			
	8. Our firm actively changes strategies and structures to respond to external environments.	0.735			
Innovation performance	1. After becoming embedded in the ecosystem, our business revenue has increased significantly;	0.719	0.513	0.808	0.808
	2. After becoming embedded in the innovation ecosystem, the cost of our products or services has fallen significantly;	0.729			
	3. After becoming embedded in the ecosystem, our firm has entered new markets;	0.722			
	4. After becoming embedded in the ecosystem, our firm has an increased market share in the industry.	0.695			
Ecological legitimacy	1. Our new product or service meets the expectations of ecological stakeholders;	0.760	0.610	0.862	0.861
	2. Our business activities are in line with the regulations and guidelines of the ecosystem;	0.789			
	3. Our business activities conform to the values and business philosophy of the ecosystem;	0.843			
	4. Our corporate image and products and services are highly evaluated and widely acceptable by ecological partners.	0.728			

Table 4
Results of the validated factor analysis fitted metrics.

Model	χ^2/ Df	RMSEA	SRMR	IFI	TLI	CFI
Five-factor model	2.119	0.056	0.053	0.926	0.916	0.925
Four-factor model	4.698	0.102	0.096	0.752	0.723	0.750
Three-factor model	5.946	0.118	0.119	0.664	0.629	0.662
Two-factor model	7.089	0.131	0.121	0.584	0.543	0.581
Single-factor model	8.404	0.145	0.123	0.492	0.445	0.489

CFI=0.925), and the degree of fit was good, which was relatively satisfactory. Combined with Table 3 and Table 5, the mean extracted variance of each variable was above 0.5, which was more significant than its correlation coefficient with other variables, demonstrating that the discriminant validity of our scale was high.

Empirical analysis and results

Descriptive statistics and correlation

Table 5 illustrates the results of the descriptive statistics and correlation analysis of the research variables in this study. The correlation analysis demonstrates significant positive correlations among the eco-embeddedness position, eco-embeddedness relation, strategic flexibility, innovation performance, and ecological legitimacy, which supports this study's research model and hypotheses. Moreover, the correlation coefficients are less than 0.5, and the values of the VIF test are less than 2, which is lower than the standard value of 10. Generally, there is no severe problem of multicollinearity, which is suitable for a further regression analysis.

Main effect analysis and mediation effect analysis

Our study added the control, independent, and mediating variables sequentially to the regression model through a hierarchical regression analysis using SPSS 26.0. The regression analysis results are exhibited in Table 6, which illustrates that Models 4–6 are the results of the main effects analysis. First, the results in Model 5 demonstrate a significant positive correlation between the eco-embeddedness position and innovation performance of non-core firms (β=0.302, p<0.001), and hypothesis H1 is verified. Then, Model 6 illustrates that the eco-embeddedness relation has a positive and significant impact on the innovation performance of non-core firms (β=0.325, p<0.001), and hypothesis H2 is supported empirically.

Accordingly, Models 8 and 9 test the mediating effect of strategic flexibility in the relationship between the eco-embeddedness position and eco-embeddedness relation and innovation performance, respectively. First, we introduce strategic flexibility into Model 8. The results demonstrate that the coefficient of eco-embeddedness position on innovation performance decreases from 0.302 (p<0.001) to 0.158 (p<0.01), combined with Model 5. Furthermore, strategic flexibility has a significant positive effect on innovation performance (β=0.308, p<0.001), indicating that strategic flexibility partially mediates the relationship between the eco-embeddedness position and innovation performance of non-core firms. Thus, hypothesis H3 is supported. Similarly, after adding the strategic flexibility variable to Model 9, the coefficient of the eco-embeddedness relation on innovation performance decreases from 0.325 (p<0.001) to 0.200 (p<0.001), combined with Model 6. Moreover, strategic flexibility has a significant positive impact on innovation performance (β=0.299, p<0.001), revealing that strategic flexibility partially mediates the relationship between the eco-embeddedness relation and innovation performance of non-core firms. Therefore, hypothesis H4 is accepted.

Moderation effect analysis

To minimize the interference of multicollinearity, this study standardized the independent and moderating variables and constructed a two-factor interaction effect product term to test the moderating effect. The model test results are exhibited in Table 7. From Model 12, the coefficient of the interaction term between the eco-embeddedness position and ecological legitimacy is 0.166 (p<0.001), which

Table 5
Descriptive statistics and bivariate correlations.

	Mean	S.D.	1	2	3	4	5	6	7	8
1. InnPer	5.186	0.765	1.000							
2. Age	2.212	1.092	−0.008	1.000						
3. AnnTurn	2.870	1.114	0.056	0.065	1.000					
4. Industry	2.590	0.851	0.044	0.048	−0.006	1.000				
5. R&D	2.893	0.890	−0.025	0.032	−0.020	−0.021	1.000			
6. EcoPos	4.541	1.036	0.301***	0.044	0.092	−0.027	0.027	1.000		
7. EcoRel	4.597	1.026	0.322***	0.011	−0.011	0.067	0.072	0.326***	1.000	
8. StrFle	4.441	0.949	0.382***	0.073	0.058	0.058	0.008	0.469***	0.416***	1.000
9. EcoLeg	4.572	1.001	0.307***	0.040	0.031	0.018	0.013	0.288***	0.241***	0.342***

Notes: *, ** and *** indicate significance at a 5%, 1% and 1‰ level, respectively

Table 6
Results of the direct effect and mediation effect tests.

Variables	StrFle			InnPer					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Age	0.066 (0.046)	0.048 (0.041)	0.064 (0.042)	−0.013 (0.038)	−0.025 (0.036)	−0.015 (0.036)	−0.039 (0.035)	−0.040 (0.034)	−0.034 (0.034)
AnnTurn	0.054 (0.045)	0.012 (0.04)	0.058 (0.041)	0.056 (0.037)	0.029 (0.035)	0.060 (0.035)	0.036 (0.034)	0.026 (0.034)	0.042 (0.033)
Industry	0.055 (0.059)	0.068 (0.053)	0.027 (0.054)	0.045 (0.048)	0.053 (0.046)	0.023 (0.046)	0.024 (0.045)	0.032 (0.044)	0.015 (0.044)
R&D	0.008 (0.057)	−0.005 (0.05)	−0.022 (0.052)	−0.022 (0.046)	−0.030 (0.044)	−0.046 (0.044)	−0.025 (0.043)	−0.029 (0.042)	−0.039 (0.042)
EcoPos		0.468*** (0.043)			0.302*** (0.038)			0.158** (0.041)	
EcoRel			0.416*** (0.045)			0.325*** (0.038)			0.200*** (0.040)
StrFle							0.382*** (0.040)	0.308*** (0.045)	0.299*** (0.043)
R^2	0.011	0.228	0.183	0.006	0.096	0.110	0.150	0.169	0.183
ΔR^2	0.011	0.216	0.171	0.006	0.090	0.104	0.144	0.073	0.073
Adjust R^2	0.000	0.216	0.171	−0.006	0.083	0.097	0.138	0.155	0.169
F value	0.986	20.499***	15.553***	0.508	7.379***	8.671***	12.294***	11.786***	12.954***

Note: *, **, *** mean p<0.05, p<0.01 and p<0.001, respectively.

Table 7
Results of moderation effect test.

Variables	StrFle				
	Model 10	Model 11	Model 12	Model 13	Model 14
Age	0.066 (0.046)	0.043 (0.040)	0.038 (0.039)	0.055 (0.041)	0.050 (0.041)
AnnTurn	0.054 (0.045)	0.011 (0.039)	0.013 (0.039)	0.050 (0.040)	0.055 (0.040)
Industry	0.055 (0.059)	0.062 (0.051)	0.067 (0.05)	0.026 (0.052)	0.029 (0.052)
R&D	0.008 (0.057)	−0.006 (0.049)	0.002 (0.048)	−0.021 (0.050)	−0.019 (0.050)
EcoPos		0.404*** (0.044)	0.375*** (0.044)		
EcoRel				0.355*** (0.045)	0.346*** (0.045)
EcoLeg		0.222*** (0.045)	0.229*** (0.045)	0.252*** (0.046)	0.252*** (0.045)
EcoPos*EcoLeg			0.166*** (0.035)		
EcoRel*EcoLeg					0.115* (0.043)
R^2	0.011	0.273	0.299	0.242	0.255
ΔR^2	0.011	0.262	0.027	0.231	0.013
Adjust R^2	0.000	0.260	0.285	0.229	0.240
F value	0.986	21.686***	21.124***	18.500***	16.963***

Note: *, **, *** indicate $p<0.05$, $p<0.01$ and $p<0.001$, respectively.

proves that ecological legitimacy positively moderates the relationship between eco-embeddedness position and strategic flexibility. Hence, hypothesis H5 is verified. Accordingly, as illustrated in Model 14, the interaction term coefficient between eco-embeddedness relation and ecological legitimacy is 0.115 ($p<0.05$), indicating that ecological legitimacy positively regulates the relationship between eco-embeddedness and strategic flexibility. Therefore, hypothesis H6 is supported. Moreover, we developed schematic diagrams of the moderating variable to better demonstrate the moderating effect of ecological legitimacy, and the results are illustrated in Fig. 2.

Robustness test

New product innovation was selected as a proxy variable for innovation performance to test the robustness of the above hypothesis. From the results displayed in Table 8, we know that after adding new product innovation as the dependent variable to the model, the regression coefficients of each model's independent and mediating variables remain consistent with the results in Table 6, respectively, which are all significant. Hence, the results obtained stay the same as the previous, verifying that the regression result is robust.

Conclusion and discussion

Main research conclusions

In the current VUCA environment, achieving innovation is crucial for the survival and development of enterprises and the creation of sustainable advantages. As competition becomes increasingly dynamic and complex, it becomes more difficult for companies to gain a competitive advantage through independent innovation. Therefore, building or participating in innovation ecosystems becomes a fundamental way for firms to obtain resources, enhance capabilities, and achieve collaborative innovation. Based on innovation ecosystem theory, strategic flexibility theory, and institutional theory, this study constructed a theoretical logic model of "innovation eco-embeddedness–strategic flexibility–innovation performance" for non-core firms and explored the effectiveness of ecological legitimacy among them. The theoretical model was tested empirically using 354 questionnaires from non-core companies, and the main findings are as follows.

First, both eco-embeddedness position and eco-embeddedness relation have significant positive effects on the innovation performance of non-core enterprises. A favorable eco-embeddedness position will help non-core firms attach to a significant number of ecological partners and access more prosperous and diverse innovation resources. Thus, it provides information, knowledge, resources, and other powerful ways of supporting enterprises to innovate. Further, a complementary relationship enables non-core firms to establish deeper communication links and higher trust stability with partners. Hence, it allows non-core enterprises to absorb muted knowledge and develop more collaborative combinations, which is conducive to achieving synergistic innovation effects.

Second, strategic flexibility partially mediates the influence of the eco-embeddedness position and eco-embeddedness relation on the innovation performance of non-core firms. It means that not only do the diversified resources and complementary assets acquired by non-core companies in the ecosystem provide direct resource support

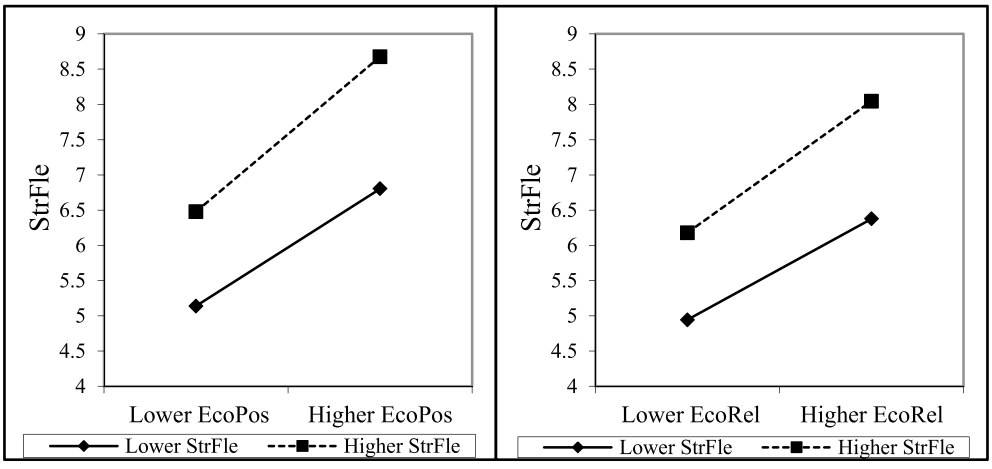

Fig. 2. Schematic diagram of the moderating effect of ecological legitimacy.

Table 8
Results of robustness test (new product innovation as dependent variable).

Variables	ProInn					
	Model 15	Model 16	Model 17	Model 18	Model 19	Model 20
Age	−0.001 (0.042)	−0.011 (0.041)	−0.003 (0.040)	−0.023 (0.04)	−0.024 (0.039)	−0.02 (0.039)
AnnTurn	0.030 (0.041)	0.006 (0.040)	0.033 (0.040)	0.012 (0.039)	0.003 (0.039)	0.017 (0.038)
Industry	0.021 (0.054)	0.028 (0.052)	0.002 (0.052)	0.002 (0.051)	0.010 (0.051)	−0.005 (0.05)
R&D	0.025 (0.051)	0.017 (0.050)	0.004 (0.05)	0.022 (0.048)	0.019 (0.048)	0.01 (0.048)
EcoPos		0.266*** (0.043)			0.139* (0.047)	
EcoRel			0.279***\ (0.043)			0.169** (0.046)
StrFle				0.336*** (0.046)	0.271*** (0.051)	0.266*** (0.050)
R^2	0.002	0.072	0.079		0.128	0.137
ΔR^2	0.002	0.070	0.077	0.112	0.057	0.058
Adjust R^2	−0.010	0.059	0.066	0.101	0.113	0.122
F value	0.163	5.389***	5.974***	0.909***	8.572***	9.161***

Note: *, **, *** indicate $p<0.05$, $p<0.01$ and $p<0.001$, respectively.

and cooperation opportunities for innovation, but they also contribute indirectly to improving innovation performance by enhancing strategic flexibility. Specifically, a favorable eco-embeddedness position and interaction with ecological members help integrate the advantages of multiple parties and grasp the allocation direction of resources to achieve maximum utilization. Therefore, it creates strategic flexibility, supporting non-core enterprises in breaking the risk of resource shackles and contributing to the success of innovation. Additionally, the interdependence and high complementarity between ecological partners improve resource capabilities' availability and matching efficiency and reduce resource conversion's time and cost loss, enhancing the ability to utilize and allocate resources. Accordingly, non-core firms can develop innovation portfolios to respond to environmental changes and market shifts, thus enhancing innovation performance.

Third, ecological legitimacy plays a moderating role in the influences of eco-embeddedness position and eco-embeddedness relation on non-core firms' strategic flexibility. Specifically, non-core enterprises are deeply embedded in a win-win ecosystem. The recognition and acceptance by core enterprises, suppliers, complementors, and other stakeholders determine the success rate of eco-embeddedness, which increases the possibility of establishing multi-party cooperation and access to resources. Therefore, it provides crucial opportunities to enrich the resource system and improve allocation capacity, which is conducive to strengthening the strategic flexibility of non-core firms. Additionally, recognition of non-core enterprises by highly complementary eco-partners facilitates deeper and closer cooperative relationships, improving their willingness to share and transfer knowledge. Hence, it supplies non-core firms with innovative resources of high utilization value, provides institutional support to integrate and absorb complementary resources and develop new resource combinations, and expands the promotion of strategic flexibility by eco-embeddedness relation.

Theoretical contributions

The main theoretical contributions are as follows. First, this study enriches the innovation ecosystem theory and contributes a non-core firm perspective to innovation ecosystem research. Adner (2017) points out that participants are one of the four core elements of the innovation ecosystem and play an inaccessible role in achieving system value co-creation. Most current studies, based on the core firm perspective, treat ecological non-core enterprises as affiliates and emphasize that the focal firm or platform enhances its bargaining power by attracting more participants into the ecosystem (Jacobides et al., 2006) and realizing value co-creation. However, there is a lack of research on non-core companies. This study delivers an in-depth analysis of the logical mechanism for non-core firms' becoming embedded in the ecosystem, which provides a new framework for subsequent empirical studies related to innovation eco-embeddedness.

Second, this study adds to the ecosystem studies related to non-core firms from strategic flexibility and institutional theory and clarifies the complex process mechanism of innovation performance enhancement of ecological non-core firms, thus providing new theoretical perspectives for innovation ecosystem research. Teece (2009) pointed out that dynamic capabilities can provide a sustained competitive advantage to firms, but little research has explored the sources and roles of dynamic capabilities of non-core enterprises in ecosystems. We introduce strategic flexibility to reveal the intrinsic mechanism of how ecological resources interact with the internal capabilities of non-core companies to influence performance, and the findings respond to Selander et al. (2013), who call for strengthening research on issues related to the construction and enhancement of firm capabilities within innovation ecosystems.

Additionally, the institutional theory emphasizes that firm activities are deeply embedded in a specific institutional environment. The Chinese system background and social culture are more distinctive, especially in an intensely interdependent ecosystem, where gaining legitimacy is strategically crucial for non-core companies. We introduced ecological legitimacy into the theoretical model, tested its moderating role empirically, and expanded the boundary conditions between innovation eco-embeddedness and strategic flexibility. Through these studies, this study aligns with the findings of Parente et al. (2018), which demonstrate that enterprises within innovation ecosystems are subject to institutional constraints, and promotes theoretical integration of institutional theory and innovation ecosystem.

Finally, this study employed a quantitative analysis to advance the research in innovation ecosystems and improve the generalizability of the ecosystem embeddedness theory. Most current research in innovation ecosystems is theoretical or qualitative. However, large-scale surveys on Chinese firms' innovation eco-embeddedness are rare. Based on questionnaire data from China, this paper investigates the research on innovation eco-embeddedness of non-core companies with a quantitative model and provides empirical evidence for the subsequent theory studies of innovation ecosystems.

Managerial implications

This paper also offers several practical inspirations for enterprises in ecosystems. First, firms should embed themselves in existing ecosystems proactively and improve their performance through ecological cooperation. The independent innovation capability of Chinese enterprises is weak, so they should join external players to collaborate on innovation. Accordingly, companies should participate actively in the ecosystem, establish connections with multiple

ecological partners to occupy a favorable ecological position, and obtain rich, diverse, and heterogeneous innovation resources, consolidating the resource base for promoting innovation activities. Meanwhile, non-core firms should focus on innovation cooperation with complementary firms and consolidate their partnerships. In this way, each complements the other's advantages, acquires high-quality innovation resources with availability and high complementarity, and realizes effective restructuring and integration of resources, hence creating new value and achieving growth-oriented cooperation.

Second, non-core enterprises must attach great importance to strengthening strategic flexibility. In participating in the ecosystem, non-core companies should search for and acquire ecological resources and focus on cultivating their capabilities. Consequently, by constructing strategic flexibility, non-core firms could realize the absorption, integration, and utilization of ecological resources and improve resource conversion efficiency and allocation capacity. Ultimately, it is helpful for non-core enterprises to develop innovative knowledge and strategies continuously and enhance their innovation's positive impact.

Third, non-core firms must improve their ecological legitimacy to gain more support. This study also emphasizes the importance of the external institutional environment in the innovation ecosystem. Non-core enterprises deeply embedded in the innovation ecosystem should conform to ecological values and ethical norms and comply with ecosystem guidelines and regulations. Moreover, they must continuously improve ecological legitimacy to earn support and recognition from stakeholders such as focal firms, suppliers, and complementors. In this way, non-core companies can maintain good cooperative relationships, ensuring the consistency of the goals and interests of the cooperative parties.

Finally, the innovation ecosystem ought to be "open" and "unique" enough to provide a more attractive platform structure for non-core companies and create an atmosphere of value co-creation. Consequently, it will help attract more complementors to enter, promote effective interaction, develop more complementary innovation among eco-partners, and thus facilitate the sustainable and healthy development of the ecosystem.

Limitations and future research

This study has limitations that deserve further in-depth exploration in the future. First, due to the data collection limitations, all variables measured in this paper are scored by corporate managers, which may have subjective bias. The cross-sectional data obtained from the questionnaire may affect the robustness and reliability of the conclusions. Hence, future studies should collect secondary and longitudinal data to obtain more accurate research conclusions. Second, this article has not yet distinguished the effect of innovation eco-embeddedness on different types of innovation. Therefore, future research can explore whether innovation eco-embeddedness has a differential effect on disparate types of innovation, such as incremental or breakthrough innovation. Third, industries were selected as control variables in this paper; however, various industries and regions may form unique ecosystems owing to differences in technology levels and resource types. Consequently, more detailed studies on the characteristics of regions and industries are necessary to acquire a more comprehensive and integrated understanding of non-core firms' innovation eco-embeddedness.

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