Innovation ecosystem stability and enterprise innovation performance: the mediating effect of knowledge acquisition

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Abstract

Purpose – *This study aims to explore the effect of innovation ecosystem stability (IES) on innovation performance of enterprises through the mediating role of knowledge acquisition (KA), and to study how these effects are moderated by unabsorbed slack.*

Design/methodology/approach – *This study draws on data from 327 Chinese enterprises and adopts the multiple linear regression method and bootstrapping method to explore the mediating effect of KA and its moderated mediating effect.*

Findings – *The results demonstrate that IES is positively associated with innovation performance of enterprises, and KA plays a partially mediating role. Moreover, unabsorbed slack negatively moderates the relationship between IES and KA as well as the mediating effect of KA.*

Originality/value – *This study investigates the relationship between IES and innovation performance, and the mechanism of influence, which has not been previously studied in the field of innovation ecosystem. This study also examines the interaction between unabsorbed slack and IES and further clarifies the mechanism and boundary conditions of the impact of IES on innovation performance.*

Keywords *Innovation ecosystem, Ecosystem stability, Knowledge acquisition, Unabsorbed slack, Innovation performance*

Paper type *Research paper*

1. Introduction

In the context of the evolving technological revolution and industrial transformation, innovation is considered to be a key factor for enterprises to gain competitive advantages and master market initiatives (Lazzarotti *et al.*, 2016). According to the knowledge-based theory, the core competence of enterprises is mainly derived from the knowledge they possess, and heterogeneous knowledge resources play a key role in enterprise innovation activities. However, given the continuously accelerating technological change cycle and the increasing difficulty and risk of innovation, enterprises can no longer meet the development needs by relying solely on internal access to the knowledge required for innovation and must renew their knowledge resources through effective external knowledge acquisition (KA) to successfully achieve research and development (R&D) innovation (Laursen *et al.*, 2011). Therefore, enterprises are constantly attempting KA through diverse collaborative networks, such as strategic alliances, targeted collaborations and licensing (Vătămănescu *et al.*, 2020). In this context, an innovation ecosystem (IE) that meets the boundary-crossing collaborative innovation demand is formed, and enterprises are increasingly choosing to create, deliver and obtain value through the IE (Adner and Kapoor, 2010). Among them, representatives include the input output system ecosystem developed by Apple, the Android ecosystem developed by Google, the Tencent IE developed by Tencent, and so on.

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Filling existing knowledge gaps and acquiring new knowledge are the most common factors for enterprises to insert into an external collaborative network (Thorgren *et al.*, 2009; Del Giudice and Maggioni, 2014). As a special external network of enterprises, the internal innovation activities of IE require the interconnection of multiple subjects. There is the synchronous transmission of technical flow, information flow and value streams in the IE (Battustella *et al.*, 2013), and the dynamic evolutionary characteristics of IE make the internal knowledge spillover and transfer mechanism more complex. The mutually beneficial symbiotic relationship between ecosystem subjects makes the stability of its operation particularly important, as an attack or disruption to the ecosystem is likely to affect the innovative activities and even the survival of all subjects. Although most studies recognize the stability of external network system has an incremental impact on the efficiency and effectiveness of enterprise innovation, some scholars have asserted opposite views, arguing that the stability of the system may lead to a rise in repeated partnerships, a locking of technology R&D track and difficulties in accessing heterogeneous resources, which affects innovation (Rodan and Galunic, 2004). Based on these contradictions, some interesting questions arise: How does innovation ecosystem stability (IES) affect enterprises' innovation levels? What is the mechanism of action? How can enterprises gain more value through stable ecosystem operations? All of these have become key realistic issues facing ecosystem stakeholders. The purpose of this study is to gain a more comprehensive understanding of the relationship between IES and innovation performance. To this end, to understand whether and how external KA mediates the relationship between IES in which the enterprise is located and innovation performance. As far as we know, most studies so far have focused on strategic alliances (Jiang *et al.*, 2018; Kumar and Zaheer, 2019), industrial clusters (Wu *et al.*, 2021) and other forms of networks, and there have been few studies on the stability of IE, the particular enterprise's external network, and even fewer from a knowledge perspective.

Moreover, a resource-based view suggests that not only the external environment of the enterprise affect heterogeneous knowledge resources acquisition but also the internal resources and capacities also play a crucial role, that is, the cooperation between internal resources and external environment jointly affects KA of the enterprise (Troilo *et al.*, 2014). Unabsorbed slack is an internal resource that is beyond the current operational needs of the enterprise and can be readily disposed (Tan and Peng, 2003). It is worth noting that there are conflicting findings in the relationship between unabsorbed slack and external knowledge search and acquisition. Some scholars have maintained that unabsorbed slack increases the depth and breadth of external knowledge search and enhances an enterprise's tolerance for innovation costs and innovation failure, thereby increasing the likelihood of new idea initiation (Lichtenthaler, 2016). However, some scholars have argued the opposite, stating that excessive slack leads to lower resource utilization and negatively affects innovation efficiency (Nohria and Gulati, 1996; George, 2005). This study considers that the paradox arises because previous studies have not dissected the types of unabsorbed slack in detail, ignoring the different mechanisms by which unabsorbed knowledge and nonknowledge slack act on KA. The Chinese Government strongly supports the innovation activities of enterprises through financial subsidies and tax subsidies in recent years, and enterprises also have an increasing amount of nonknowledge unabsorbed slack. The strategy chosen by enterprises with different levels of slack must be adjusted, but the research is relatively limited. Therefore, this study focuses on the impact of nonknowledge unabsorbed slack in the operation process of enterprises. In the context of China, we define unabsorbed slack as accumulated cash, retained earnings, borrowing capacity, inventory of raw materials and other nonknowledgeable resources over the current operational needs of the enterprise that can be flexibly allocated.

This study responds to Emily *et al.* (2019) and Yaghmaie and Vanhaverbeke's (2020) call for more studies on the need to address the value capture and knowledge transfer mechanisms in IE. In this sense, this study explores the antecedents of enterprises' innovation performance from a knowledge perspective and contributes to a better comprehension of the nature of IE. Moreover, most existing studies are case studies or other forms of qualitative investigation, and quantitative studies are lacking. Our study places IES, KA, unabsorbed slack and innovation performance in a single research framework, further combining and summarizing intrinsic logic and deep mechanisms. We analyze the interaction between external IES and internal unabsorbed slack on KA and innovation performance by examining a sample of 327 enterprises as an empirical test to clarify the specific process mechanism of KA. This study offers suggestions and references regarding strategies that can be adopted by enterprises with different positions in the IE and enterprises with different levels of unabsorbed slack by analyzing the optimal conditions for enterprises to acquire knowledge.

The results demonstrate the effect of IES on innovation performance. Specifically, IES positively affects KA, and KA positively affects innovation performance; thus, KA holds a partially mediating role. In addition, the results show that unabsorbed slack negatively moderates the relationship between IES and KA, and negatively moderates the mediating effect of KA, i.e. there is a moderated mediation effect.

2. Theoretical background and hypotheses development

2.1 Innovation ecosystems and innovation ecosystem stability

2.1.1 Innovation ecosystems. Previously, cooperative innovation between organizations was predominantly conducted through signing bilateral agreements from a two-dimensional perspective in which both parties would exchange knowledge and technical resources to complete innovative R&D projects (Kale and Singh, 2009; Agarwal *et al.*, 2010). With accelerated technological progress and development, the rapid iteration of products and services now forces enterprises to seek common value creation and acquisition through diversified collaboration and interaction to achieve more complex value propositions (Adner, 2006). The resulting value network is referred to as IE.

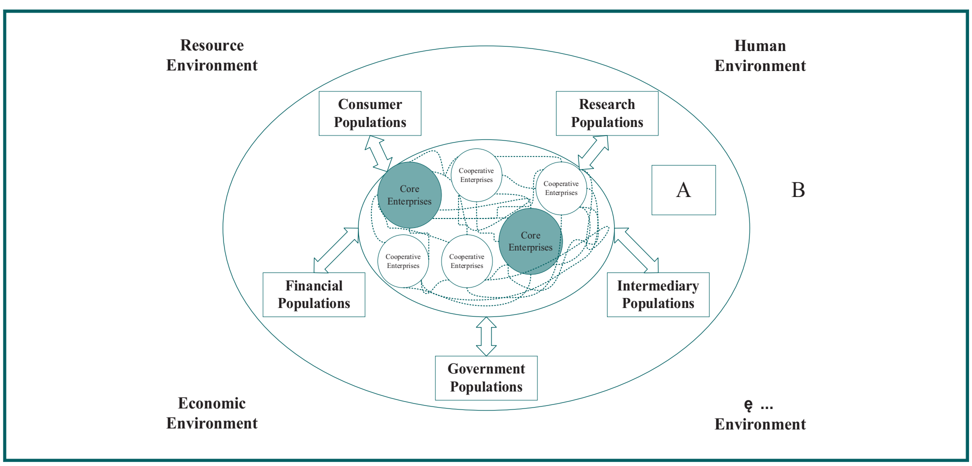
Since Adner (2006) first proposed the term IE, researchers have performed a considerable amount of research on the origin (Jacobides *et al.*, 2018), concept (Iansiti and Levien, 2004a, 2004b; Adner, 2006; Li, 2009; Tiwana *et al.*, 2010; Battustella *et al.*, 2013; Adner, 2017), evolution (Rohrbeck *et al.*, 2010; Xiao *et al.*, 2019; Benitez *et al.*, 2020), characteristics (Moore, 1996; Ritala and Almpanopoulou, 2017) and related topics. IE is a complex network by nature. Tiwana *et al.* (2010) found that during the rapid development of the internet, innovation subjects of different types and areas spontaneously broke through industrial and regional restrictions based on multilateral interaction and heterogeneous resource acquisition needs, connecting to form a collaborative professional, networked and complementary IE. Li (2009) emphasized that connectivity in the IE is weak and the network structure is loose, generating favorable conditions for flexible relationship changes among innovation subjects. Adner (2017) highlighted that IE can be understood as an alliance network structure formed by multiple heterogeneous subjects sharing common value propositions. Battustella *et al.* (2013) proposed that, in essence, IE is a network organization system spontaneously formed by a large number of interdependent, mutually trusting and interacting subjects. Such systems are connected through core enterprises that function as nodes linking the supply side to the demand side.

Furthermore, scholars studied IE from the perspective of disruptive innovation (Ansari *et al.*, 2015), dynamic capability (Lutjen *et al.*, 2019) and ecological niches (Brem and Radziwon, 2017). To date, the study of IE has evolved to cross-fusion research with digital platforms (Gawer and Cusumano, 2014; Wang and Miller, 2020), value creation and value acquisition (Adner and Kapoor, 2010; Clarysse *et al.*, 2014), co-opetition (Hannah and Eisenhardt, 2018; Jones *et al.*, 2021) and knowledge management (Chesbrough and Appleyard, 2007). As an emerging issue at the intersection of management, economics and ecology, IE has attracted widespread attention, reaching academic consensus regarding a definition: a mutually dependent and symbiotic organizational system formed by multiple subjects with matching innovation elements such as talent, technology, information and culture (Adner, 2006).

Nevertheless, the concept of IE differs from other innovation networks or innovation alliances in that it emphasizes the "ecological" character of the system. First, the main objective of IE is value creation. Members of the ecosystem are not limited to the cooperative enterprise but consider all participating organizations and individuals involved in the innovative activities as well as external environmental factors. Individuals of the same type aggregate into innovation populations, and all innovation populations aggregate together to form innovation communities, which together with the external environment form the entire IE. The specific biological components of IE include core enterprises, partners, consumers, universities and institutes, government departments, financial institutions, intermediaries and a series of additional interactive organizations (Teece, 2007; Breslin *et al.*, 2021). Among them, core and cooperative enterprises form enterprise populations. Core enterprises are commonly the leaders and coordinators of IE, helping innovation actors to establish partnerships, attracting other subjects to enter the ecosystem and controlling the operation of the entire ecosystem. Cooperative enterprises include suppliers, assemblers, complementors and other businesses supporting collaborative production. Consumer populations' demands are the most heterogeneous aspects of an entire IE, and the most closely related to real market trends. Government populations implement a series of policies to ensure the stability of economic and political environments and actively promote the coordination and cooperation of various innovation subjects. Research populations composed of universities and institutes provide professional technical consultation and breakthrough innovation knowledge, which is the main source of innovation output. Financial populations and intermediary populations play a bridging and boosting role to ensure the smooth implementation of innovation activities (Afuah, 2000; Dedehayir *et al.*, 2018). The external environment constitutes abiotic components of IE, including human environment, economic environment, resource environment and so on. Due to the uncontrollable nature of the external environment, this study focuses on the stability of the biotic components of IE (i.e. the Range A in Figure 1) and does not discuss the stability of the external environment.

Second, as a metaphorical ecological system architecture, the development of IE unfolds in a self-organizing evolutionary process, the core feature of which is the symbiotic evolution

Figure 1 Innovation ecosystem



of the entire ecosystem, as opposed to simple forms of competition and cooperation between various innovation subjects (Moore, 1996). This perspective is supported by several studies. Afuah (2000) applied an ecological perspective finding that each innovation subject participates in the IE in a symbiotic state. Zahra and Nambisan (2011) demonstrated that core enterprises can provide fertile ground for innovation activities for SMEs, and the cooperative symbiosis of various subjects is the basis for the development and evolution of IE. Li's (2009) case study indicated that innovation resources are key to enterprises' competitive advantage, and the process of innovation resource flow is characterized by contact and interaction among members, which is the main impetus for the evolution of each innovation subject within the ecosystem from fighting alone to cultivating symbiosis. Furthermore, IE is not limited by supply chains, locations, industries or platforms and has fuzzy and fluid boundaries. A healthy IE does not necessitate a hierarchical governance mechanism but requires all members to independently make decisions and jointly innovate more complex products or services to maximize value capture and value creation, ultimately achieving a self-generated evolution of the entire ecosystem (Lichtenthaler, 2011; Jacobides *et al.*, 2018).

2.1.2 Innovation ecosystem stability. Ecosystem stability includes the dynamic characteristics of all aspects of an ecosystem. Scholars have studied it from multiple angles and dimensions. According to the statistics of Grimm and Wissel (1997), there are 163 definitions of ecosystem stability in ecological literature, among which the more classic ones refer to the resistance of the system when it is attacked or damaged and the recovery ability to quickly recover to the initial level (Mccann, 2000). IE is similar to the natural ecosystem, both based on the cooperation and competition between species, with energy flow, and promotes the dynamic evolution of the overall ecosystem. So, combining features of IE, we consider that IES refers to the ability of all innovative entities to jointly withstand external environmental risks through interdependence, mutually beneficial and symbiotic network relationships and to keep the ecosystem running stably and evolving continuously forward.

Grimm and Wissel (1997) argued that natural ecosystem stability includes constancy, resilience and persistence. Constancy refers to the natural ecosystem fluctuations within a certain range, and the overall is substantially stable. Resilience can be considered as the ability to restore to the original level after interference. Persistence is the continuing existence of the natural ecosystem. Referring to natural ecosystem stability, we consider that IES includes structural stability (the basic condition for maintaining IES), technological adequacy (the guarantee for subjects to resume normal operation through rapid response aftermarket changes) and policy support (external guarantee for the sustainable existence of IE). First, IES greatly depends on structural stability within the ecosystem. Structural stability is the result of the harmonious complementarity of information, value and energy, and is the prerequisite and guarantee for healthy ecosystem operation (Côté and Cohen, 1998). The diversity of ecosystem members and the quality of their relationships can effectively ensure the stable operation of ecosystems and enhance their ability to resist external disturbances (Bojica and Fuentes, 2012; Hemmert *et al.*, 2014). In addition, technological adequacy is the resource guarantee to maintain ecosystem stability in the face of external market changes. It must be acknowledged that the stability of IE is relative, while the dynamism of IE is universal. For a healthy ecosystem, the gap between new and old technologies is a potentially destabilizing factor. During the contemporary cycle of continuous improvement, when an update is made to a core product and technology, cooperative subjects are required to develop corresponding technical updates through immediate innovation to ensure the efficiency and effectiveness of ecosystem cooperation. Such cooperation requires sufficient guaranteed technical reserve. To maintain the state of technological adequacy, the number of cooperative subjects continuously rises, the cooperative network keeps expanding and evolving, and the IE fluctuates and continues to evolve within a demonstrably normal range (Deutz *et al.*, 2003; Moors *et al.*, 2005). Finally, policy support is a strong power for the stable operation of an ecosystem. China has a late start in promoting the IE, and its governance mechanism is not yet mature. Innovation subjects are often vulnerable to market failures, such as high transaction costs and opportunistic behavior. If the government does not provide enabling environment, cooperation among members can be expected to break down, potentially leading to the collapse of the entire ecosystem (Dong *et al.*, 2021). Therefore, the government has a meaningful influence on the stable operation and evolution of the IE (Yan and Guan, 2018).

2.2 Innovation ecosystem stability and enterprise innovation performance

The stable operation of the IE provides a significant guarantee of orderly evolution (Rosenzweig, 2009). To meet the accelerated demand for products and services, innovation subjects typically choose to increase their advantages through collaboration and association in innovation strategies. However, the nonhierarchical and boundary-free characteristics of the IE lead to the complexity and unsteadiness of internal innovation subjects. Faced with such an emerging and loose ecosystem structure, are members willing to give up traditional bilateral cooperation modes to assume the innovation cooperation mode with greater risks? The choice depends on whether IE can run stably and healthily and whether members can obtain more benefits from the stable IE.

- Structural stability and innovation performance

  The IE with unstable structures can involve many hidden dangers, such as opportunistic behaviors of technology and information theft by partners due to the game of interests, which aggravate the risks of cooperation and raise the cost of innovation (Rogan and Greve, 2015). In contrast, the stable ecosystem can effectively reduce transaction costs and internalize external challenges in innovation activities, thus promoting cooperation among innovation subjects and significantly improving cooperation efficiency. That means a stable ecosystem structure is more resistant to environmental disturbance as a whole and can respond quickly to turbulent market and economic environments, assuming a preemptive innovation advantage and the ability to expediently seize and leverage opportunities for innovative products to enter the market, which enhances innovation performance considerably. Therefore, enterprises can achieve a higher level of innovation output through active involvement in a stable IE than they could have independently (Williamson, 2008).

- Technological adequacy and innovation performance

  The symbiotic development of various subjects in the IE benefits from the technological interdependence between key products and other complementary products (Adner and Kapoor, 2010). IE is a system formed based on technology, and the emergence of technological bottlenecks is likely to directly affect the operating efficiency of the whole ecosystem (Hughes, 1983). However, technological bottlenecks are not to be overcome by the developers of new technologies alone but require collective progress among a series of interdependent upstream and downstream components and complementary suppliers. When a product's technology is updated, if existing complementary products cannot be rapidly updated, it may lead to large circular modification of the whole design process line and waste innovation resources (Ethiraj, 2007). For example, through the research on the electric power system, Hughes (1983) found that when the technological innovation of some elements in an ecosystem lags behind other elements, it will cause certain obstacles to the operation of the system. In a study of the semiconductor industry, Henderson (1995) emphasized the critical role of suppliers, customers and complementors in the performance trajectory of optical lithography technology. Constant (1980) argued that engine component suppliers and fuel, lubricating oil and other complementors have had a significant impact on the rise of aircraft piston engine technology. The above research indicates that a technologically adequate IE enables the smooth implementation of innovation activities, provides valuable solutions for customers and improves innovation performance of enterprises.

- Policy support and innovation performance

  The uncertainty of the results of innovation activities makes them inherently riskier than ordinary business activities. The considerable expenditure required for R&D is also a key factor restricting innovation activities. Various supportive policies provided by the government can decrease the risk of investing in R&D (Hall and Harhoff, 2012). Specifically, according to endogenous growth theory, R&D innovation has a positive externality, as it exerts a knowledge spillover effect (Romer, 1986). Policy support can compensate for enterprises' insufficient investment return on innovation activities, effectively solving the market failure phenomenon and further guiding enterprises to cultivate innovation input, generating a crowding-in effect and subsequently improving innovation output (Gonzalez and Pazo, 2008; Carboni, 2011). Conversely, an uncertain government attitude or absence of incentive policies can delay enterprises' innovation investment decisions. Second, effective governance is important for innovation activities (Jacobides *et al.*, 2018). Certain policy interventions can effectively regulate the IE, reduce cooperation risk among innovation subjects, diminish organizational conflict and lower management costs, thus promoting innovation collaboration and significantly improving enterprises' innovation benefits.

Based on the above analysis, the following assumptions are proposed (structural stability = *H1a*, technological adequacy = *H1b* and policy support = *H1c*):

H1(a, b, c). IES (structural stability, technological adequacy and policy support) has a significant positive impact on innovation performance.

2.3 Innovation ecosystem stability, knowledge acquisition and enterprise innovation performance

According to the knowledge-based theory, the core reason for the difference in the competitive advantage of enterprises is knowledge, which is also the main source for improving innovation levels (Grant, 1996). The characteristics of complementarity and dependence make it possible to accumulate considerable knowledge, information and data in an IE (Chae, 2019). Technology transfer and knowledge spillover in the collaborative innovation process are the major channels for acquiring heterogeneous external knowledge resources, which provide conditions for the next step of enterprise innovation activities (Bin, 2008; Fabrizio, 2009).

- Structural stability, KA and innovation performance

  Compared with the IE with unstable structures, the IE with stronger interdependence among system members and more robust operations is more convenient to capture knowledge relevant to superior innovation performance (Hansen, 2002). Given the openness of IE and the fuzziness of boundaries, enterprises can facilitate integrated innovation with cross-industry and cross-regional partners to bridge the technological gap and existing internal shortcomings and achieve beneficial cross-organizational learning. When an enterprise has close relationships, and a high degree of familiarity with cooperative innovation partners, sensitivity to knowledge can be enhanced, helping the enterprise to quickly identify those with the required knowledge and the best paths to KA (Nooteboom, 2000; Camisón and Forés, 2011). A structurally stable IE also contributes to the establishment of trust mechanisms. The nature and purpose of the innovation subjects in the ecosystem differ, so a sound trust mechanism provides the basis for an innovation subject to be rooted in the ecosystem. Improvement of the trust mechanism is conducive to improving the frequency and quality of interaction between various subjects, ensuring continuous information sharing and timely delivery of information from the external environment to the enterprise, thereby reducing innovative risks (Argyres *et al.*, 2020). In addition, the IE with high structural stability can also easily make embedded tacit knowledge explicit, lower the cost of KA of enterprises, and lift the efficiency of KA, with an incremental effect on innovation performance (Glaeser *et al.*, 2000; Yan and Guan, 2018).

- Technological adequacy, KA and innovation performance

  Specialization and the ability to expediently respond to innovations are crucial to enterprises' survival. Only by quickly and accurately acquiring customer demand information and knowledge regarding the latest technology can enterprises seize market opportunities and obtain innovation advantage. First, in an IE, the previous bilateral cooperation model is overturned, the locked cooperation objective is dismantled, and different aspects of products are allowed to be designed and produced separately. An IE with sufficient technological reserves generates the conditions for enterprises to implement more competitive and professional modular cooperation (Ethiraj and Levinthal, 2004). This transformation both expands the channel of KA and strengthens the depth and professionalism of acquired knowledge. Second, identifying innovation subjects' knowledge needs depends on their technical knowledge accumulation, and existing products and technology upgrading reserves are the premise of external KA (Cohen and Levinthal, 1990; Smith and Clark, 2005). If the IE is technologically adequate, the technological distance between innovation subjects is short. As a result, downstream technology innovation subjects can react quickly to changes in upstream technology, and identify and acquire relevant technical knowledge to ensure the convergence speed of technological transformation.

- Policy support, KA and innovation performance

  The degree of policy support for IE affects each member's psychological expectations of IE for future development. Favorable policies reduce the uncertainty of R&D investment in innovation activities (Mamuneas and Nadiri, 1996; Hall and Harhoff, 2012). On the one hand, the IE with policy support can attract more innovative subjects, broaden channels of KA and access more heterogeneous knowledge information. On the other hand, preferential policies such as fiscal, tax and financial support from the government for the development of IE help enterprises to improve internal enthusiasm for innovation cooperation. A strong willingness to cooperate can raise system flexibility, and realize the cost reduction of KA and management innovation, to improve enterprises' innovation performance.

Based on the above analysis, the following assumptions are proposed (structural stability = *H2a*, *H3a*; technological adequacy = *H2b*, *H3b*; policy support = *H2c*, *H3c*):

H2(a, b, c). IES (structural stability, technological adequacy and policy support) has a significant positive impact on KA.

H3(a, b, c). KA has a mediating effect between IES (structural stability, technological adequacy and policy support) and innovation performance.

2.4 Innovation ecosystem stability, knowledge acquisition and unabsorbed slack

Organizational slack, a type of strategic flexible resource, generally exists in all organizations and provides a "resource pool" beyond an enterprise's requirements to support daily business activities. Unabsorbed slack is often regarded as a reserve "buffer" in case an enterprise encounters a negative impact. High liquidity enables enterprises to meet preventive needs regarding potential external environment changes.

A stable IE can effectively reduce opportunistic behavior and lower transaction costs. Specifically, a structurally stable IE is conducive to the formation of trust mechanisms among innovation subjects; an IE's technological adequacy contributes to the transparency and interaction of knowledge, for example, the modular architecture makes an interface standardized and unified, facilitating an abundant knowledge resources overflow; government financial support and preferential policies encourage cooperation between innovation subjects and improve the willingness of enterprises to exchange knowledge resources. When enterprises have little unabsorbed slack, they tend to be more concerned about the cost and risk of KA and, therefore, prefer to acquire knowledge through a stable IE. That is, the positive effect of IES on KA is enhanced in the context of low unabsorbed slack.

However, when there is a high level of unabsorbed slack, principal-agent problems will likely arise. According to the agency theory, unabsorbed slack will lead to problems such as managers' relaxation, negligence, self-interest and other problems (Ross, 1973). An abundance of unabsorbed slack within an enterprise triggers the emergence of managers' blind optimism, which causes an irrationally expanding the scope of knowledge search and reduces attention to the validity of knowledge. This leads to excessive consumption of resources in the search process and increases the cost of screening for effective knowledge information, reducing the efficiency of KA (Geiger and Makri, 2006). In addition, the diversified investment may distract enterprises' energy, making it difficult to quickly identify the best path to acquire knowledge, which affects the depth of KA in the core business areas (Mishina *et al.*, 2004; Xu, 2015). That is, the positive effect of IES on KA is diminished in the context of high unabsorbed slack.

Based on the above analysis, the following assumptions are proposed (structural stability = *H4a*; technological adequacy = *H4b*; policy support = *H4c*):

H4(a, b, c). Unabsorbed slack negatively moderates the impact of IES (structural stability, technological adequacy and policy support) on KA.

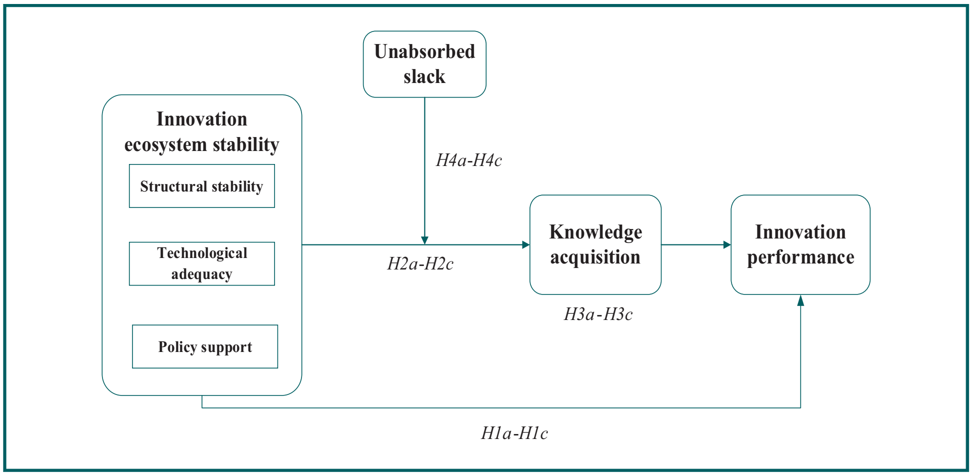
By aggregating all the above hypotheses, the conceptual model presented in Figure 2 was designed.

3. Methods

3.1 Research samples and data collection

Since we focus on the impact of IES on enterprises' innovation performance, sample enterprises must be members of the existing IE and the respondents must have a full understanding of the innovation activities conducted by enterprises through IE. To better

Figure 2 Theoretical model diagram



verify the hypotheses of this study, a random sampling method was used to conduct a questionnaire survey:

- Based on the research theme of this study, five regions – Beijing, Shanghai, Guangdong, Zhejiang and Jiangsu – were selected as sample areas for questionnaire distribution, primarily because innovation achievements of these regions have been more prominent in recent years, IE has a superior development momentum and the innovation activities are representative.
- This study selected samples from the software and information technology sector, electronic and mechanical manufacturing sector and biopharmaceutical sector. These sectors require more technological collaboration and communication, and often create, deliver and capture value through IE; therefore, their characteristics correspond with the aims of this study.
- Middle and senior managers of enterprises above the designated size were selected for surveys to avoid the situation that enterprises are on the edge of the IE and respondents with little understanding of enterprises' activities in the IE. Enterprises' designated sizes were determined by the latest standards formulated by the National Bureau of Statistics in 2011.
- The item, "How familiar are you with the operation of the relationship between the enterprise and other innovation subjects?" was set, and answers of respondents indicating "very familiar" and "relatively familiar" were retained to ensure the scale's validity.

This study conducted a two-stage survey. In the preliminary investigation stage, we conducted a questionnaire pretest with nine experienced academic researchers and seven middle and senior enterprise managers and modified or deleted the problematic items identified. On this basis, 45 questionnaires were collected, the questionnaire was further studied and revised according to the preliminary survey results, and finally, the formal questionnaire was determined. Questionnaires were primarily distributed through a combination of electronic questionnaires and field research. We distributed 457 questionnaires, of which 431 were returned. Excluding 104 invalid questionnaires with incomplete answers or respondents who were unfamiliar with the operation of the relationship between enterprises and other innovation subjects, 327 valid questionnaires remained, with a collection efficiency of 75.9%. The basic characteristics of sample enterprises are shown in Table 1.

Table 1 Descriptive statistics of the sample

Characteristic	*Classification*	*No.*	*Proportion (%)*
Position	Senior management (Chairman, CEO, etc.)	54	16.51
	Middle and senior management of R&D department	113	34.56
	Middle and senior management of marketing department	94	28.75
	Middle and senior management of sales department	49	14.98
	Middle and senior management of other departments	17	5.20
Enterprise scale (number of employees) (ES)	$<$200	56	17.13
	200–499	100	30.58
	500–999	77	23.55
	1,000–1,999	45	13.76
	$>$2,000	49	14.98
Enterprise nature (EN)	State-owned enterprise	38	11.62
	Private enterprise	221	67.58
	Joint venture enterprise	41	12.54
	Foreign capital enterprise	27	8.26

Note: CEO = Chief executive officer

We performed a multicollinearity test on the samples using SPSS 23.0, and the results showed that the variance inflation factors were all less than the critical value of 5 (Hair *et al.*, 2006), indicating no multicollinearity problem between variables. In addition, a further test for common method bias was conducted. The most commonly used technique is Harman's single-factor test, but Podsakoff *et al.* (2003) suggested that Harman's single-factor test has a poor effect and cannot provide a valid assessment. Therefore, this study used the method proposed by Richardson *et al.* (2009) to build a two-factor model by adding a common method factor to the model. The results showed that the change in the main fit indices between the two-factor model and the model with only the trait factors were ΔNFI = 0.009, ΔIFI = 0.004, ΔCFI = 0.005 and ΔRMSEA = 0.003, all of which were less than 0.01, indicating that the model was not significantly improved by the addition of the common method factor, i.e. there is no significant common method bias.

3.2 Variables

To ensure accuracy and validity in the measurement of research variables, the measurement tools used in this study were revised based on existing relevant scales. We first translated and back-translated the English scale, and corrected unclear and ambiguous items according to the context. In terms of questionnaire design, other than basic respondent and enterprise information, we used the five-point Likert scale, with 1 representing very inconsistent and 5 representing very consistent (the specific items are presented in Appendix).

The questions regarding innovation performance referenced Chen *et al.* (2011) with four items. Considering that industry characteristics may affect innovation performance, this instrument was preceded by the words "compared to the industry average," asking respondents to compare with the industry average in a cross-sectional manner to ensure the accuracy of their responses. The measurement of structural stability of IE was adapted by referencing Côté and Cohen (1998), Kincaid and Overcash (2001), Desrochers (2001) and Hardy and Graedel (2002) with four items. Technological adequacy of IE was measured by referencing Deutz *et al.* (2003) and Moors *et al.* (2005), which include four items. Policy support of IE was adapted from Feller *et al.* (2002) with three items. KA was measured using the four-item scale of Lyles and Salk (1996). The measurement of unabsorbed slack was adapted from Tan and Peng (2003) with four items.

This study posits that innovation performance may be affected by KA and IES as well as the nature and scale of enterprises. Therefore, it is necessary to include in the research scope as a control variable (set to dummy variables). We divided the enterprise scale into five levels, from less than 200 employees to 2,000 and above employees, with codes of 1–5, respectively. The nature of enterprises was divided into four categories: state-owned enterprise, private enterprise, joint venture enterprise and foreign capital enterprise, with codes of 1–4, respectively.

4. Empirical analyses

4.1 Reliability and validity test

We first tested reliability and validity before evaluating the relationship between variables. We used SPSS 23.0 to analyze Cronbach's α. As displayed in Table 2, the internal consistency α coefficients of all variables are above 0.7, indicating that the scale has good internal consistency and high reliability (Nunnally and Bernstein, 1994).

We used AMOS 24.0 to examine the scale's validity by constructing a structural equation model, which includes three aspects of content validity, convergent validity and discriminant validity. Content validity was ensured by drawing on existing scales and repeatedly revising them. In terms of convergent validity, we judged by confirmatory factor

Table 2 Reliability and validity analysis of variables

Variable	*Item*	*Loading*	*AVE*	*CR*	*Cronbach's α*
Structural stability (IES1)	IES11	0.801	0.603	0.858	0.855
	IES12	0.802			
	IES13	0.685			
	IES14	0.810			
Technological adequacy (IES2)	IES21	0.791	0.605	0.859	0.859
	IES22	0.756			
	IES23	0.756			
	IES24	0.806			
Policy support (IES3)	IES31	0.838	0.675	0.862	0.861
	IES32	0.793			
	IES33	0.833			
Knowledge acquisition (KA)	KA1	0.821	0.621	0.867	0.864
	KA2	0.741			
	KA3	0.756			
	KA4	0.829			
Unabsorbed slack (US)	US1	0.754	0.575	0.802	0.802
	US2	0.727			
	US3	0.792			
Innovation performance (IP)	IP1	0.741	0.561	0.836	0.834
	IP2	0.707			
	IP3	0.753			
	IP4	0.793			

analysis. If the factor loadings > 0.6, average variance extracted (AVE) > 0.5 and composite reliability (CR) > 0.7, the scale passes convergent validity test (Hair *et al.*, 2006). As shown in Table 2, the factor loadings > 0.6, AVE > 0.5 and CR > 0.8. All the indicators meet the critical values, indicating that the scale has good convergent validity. The test of discriminant validity was determined by comparing the square root of AVE with the absolute value of the correlation coefficient between variables. If the square root of AVE is greater than the correlation coefficient between variables in the structure, it indicates that the discriminant validity between the variables in the model is good (Fornell and Larcker, 1981). As shown in Table 3, the square root of AVE on the diagonal is greater than all other values on its rows and columns, which indicates that our scale has good discriminant validity.

In addition, we tested the fit of the theoretical model proposed in this study through the model fit metrics. The results showed that all results meet the ideal state, X^2/degrees of freedom = 1.320 [<3 threshold] (Hair *et al.*, 2006; Schumacher and Lomax, 1996); normed fit index (NFI) = 0.943 [>0.9 threshold]; incremental fit index (IFI) = 0.986 [>0.9 threshold]; comparative fit index (CFI) = 0.985 [>0.9 threshold]; the root mean square error of

Table 3 Results of mean, standard deviation, correlation coefficients and reliability statistics

Variable	*Mean*	*SD*	*EN*	*ES*	*IES1*	*IES2*	*IES3*	*KA*	*US*	*IP*
EN	2.17	0.74	1							
ES	2.79	1.30	0.170**	1						
IES1	3.73	0.85	0.006	−0.091	(0.777)					
IES2	3.88	0.86	0.038	0.013	0.606**	(0.778)				
IES3	3.92	0.92	0.000	−0.019	0.595**	0.690**	(0.822)			
KA	4.01	0.84	0.041	−0.042	0.602**	0.743**	0.668**	(0.788)		
US	3.90	0.83	−0.029	0.008	0.562**	0.652**	0.597**	0.680**	(0.758)	
IP	3.82	0.80	0.113*	0.054	0.528**	0.667**	0.595**	0.704**	0.690**	(0.749)

Notes: n = 327; $^{*}p < 0.05$ and $^{**}p < 0.01$. The number in brackets on the diagonal is the square root of AVE approximation (RMSEA) = 0.023 [<0.08 threshold] (Hu and Bentler, 1999). Therefore, the sample data matches the model to a high degree.

4.2 Hypothesis testing

The relationships among variables were examined by hierarchical regression analysis. In Table 4, we examined the direct impact of IES on KA and innovation performance, and the mediating role of KA between IES and innovation performance. To test the positive impact of IES on innovation performance, regression Model 1 with innovation performance as the dependent variable was constructed. The results showed that there are significant positive correlations between IES (structural stability, technological adequacy and policy support) and innovation performance (β = 0.145, p = 0.006 < 0.01; β = 0.426, p = 0.000 < 0.001; β = 0.216, p = 0.000 < 0.001), supporting *H1a*, *H1b* and *H1c*. To test the positive impact of IES on KA, regression Model 2 with KA as the dependent variable was constructed. The results showed that there are significant positive correlations between IES (structural stability, technological adequacy and policy support) and KA (β = 0.169, p = 0.000 < 0.001; β = 0.474, p = 0.000 < 0.001; β = 0.240, p = 0.000 < 0.001), supporting *H2a*, *H2b* and *H2c*.

This study tested the mediating effect of KA by the bootstrap method. We selected Model 4, set random sampling for 5,000 times and estimated the confidence interval under 95% confidence level. The result of the mediation test (IES1→KA→IP) showed direct (Boot 95% confidence Interval (CI) = [0.0744, 0.2538]) and indirect effects (Boot 95% CI = [0.2495, 0.4290]), the result of the mediation test (IES2→KA→IP) showed direct (Boot 95% CI = [0.1922, 0.3978]) and indirect effects (Boot 95% CI = [0.2176, 0.4271]) and the result of the mediation test (IES3→KA→IP) showed direct (Boot 95% CI = [0.1118, 0.2872]) and indirect effects (Boot 95% CI = [0.2313, 0.4138]). The above results indicate that KA has a partial mediating effect between all dimensions of IES and innovation performance; thus, *H3a*, *H3b* and *H3c* are supported.

The moderating effect analysis results are presented in Table 5. Unabsorbed slack negatively moderates the relationship between IES (structural stability, technological adequacy and policy support) and KA (β = −0.216, p = 0.000 < 0.001; β = −0.167, p = 0.000 < 0.001; β = −0.232, p = 0.000 < 0.001). *H4a*, *H4b* and *H4c* are supported by the empirical data.

Table 4 Results of mediating effect

	Model 1 Dependent variable: IP			Model 2 Dependent variable: KA		
Variable	*β*	*t*	*p*	*β*	*t*	*p*
EN	0.087	2.186	0.030	0.027	0.777	0.438
ES	0.051	1.270	0.205	−0.033	−0.937	0.349
IES1	0.145	2.766	0.006	0.169	3.674	0.000
IES2	0.426	7.350	0.000	0.474	9.319	0.000
IES3	0.216	3.778	0.000	0.240	4.795	0.000
IES1 → KA → IP	Direct effect	Boot SE = 0.0456; Boot 95% CI (LLCI = 0.0744, ULCI = 0.2538)				
	Indirect effect	Boot SE = 0.0459; Boot 95% CI (LLCI = 0.2495, ULCI = 0.4290)				
IES2 → KA → IP	Direct effect	Boot SE = 0.0523; Boot 95% CI (LLCI = 0.1922, ULCI = 0.3978)				
	Indirect effect	Boot SE = 0.0538; Boot 95% CI (LLCI = 0.2176, ULCI = 0.4271)				
IES3 → KA → IP	Direct effect	Boot SE = 0.0446; Boot 95% CI (LLCI = 0.1118, ULCI = 0.2872)				
	Indirect effect	Boot SE = 0.0461; Boot 95% CI (LLCI = 0.2313, ULCI = 0.4138)				

Notes: LLCI: lower limit of confidence interval; ULCI: upper limit of confidence interval

Table 5 Results of moderating effect

Variable	Model 3 Dependent variable: KA β	t	p	Model 4 Dependent variable: KA β	t	p	Model 5 Dependent variable: KA β	t	p
EN	0.061	1.638	0.102	0.047	1.362	0.174	0.062	1.741	0.083
ES	−0.036	−0.949	0.343	−0.055	−1.603	0.110	−0.038	−1.077	0.282
IES1	0.279	6.115	0.000						
IES2				0.483	10.641	0.000			
IES3							0.368	8.298	0.000
US	0.396	7.838	0.000	0.259	5.198	0.000	0.315	6.256	0.000
IES1 × US	−0.216	−4.604	0.000						
IES2 × US				−0.167	−3.724	0.000			
IES3 × US							−0.232	−5.047	0.000

Route	Moderated mediation	Effect	Boot SE	BootLLCI	BootULCI
IES1 → KA → IP	eff1(M − 1SD)	0.2313	0.0431	0.1510	0.3203
	eff2(M)	0.1579	0.0355	0.0935	0.2319
	eff3(M + 1SD)	0.0846	0.0396	0.0108	0.1658
IES2 → KA → IP	eff1(M − 1SD)	0.2561	0.0415	0.1745	0.3368
	eff2(M)	0.2118	0.0388	0.1376	0.2876
	eff3(M + 1SD)	0.1675	0.0410	0.0887	0.2483
IES3 → KA → IP	eff1(M − 1SD)	0.2426	0.0360	0.1748	0.3147
	eff2(M)	0.1768	0.0320	0.1190	0.2436
	eff3(M + 1SD)	0.1109	0.0352	0.0468	0.1857

Notes: LLCI: lower limit of confidence interval; ULCI: upper limit of confidence interval

This study tested the moderated mediating effect of KA by bootstrap method. We selected Model 7, set random sampling for 5,000 times and estimated the confidence interval under 95% confidence level. As shown in Table 5, under low unabsorbed slack, the indirect impact of structural stability, technological adequacy and policy support on innovation performance through KA is significant (95% confidence intervals are [0.1510, 0.3203], [0.1745, 0.3368] and [0.1748, 0.3147], excluding 0). Under high unabsorbed slack, the indirect impact of structural stability, technological adequacy and policy support on innovation performance through KA is still significant (the 95% confidence intervals are [0.0108, 0.1658], [0.0887, 0.2483] and [0.0468, 0.1857], excluding 0), but the coefficient decreases. Therefore, with the enhancement of unabsorbed slack, the mediating role of KA between structural stability and innovation performance, between technological adequacy and innovation performance and between policy support and innovation performance is weakened. In summary, unabsorbed slack negatively moderates the indirect effect of IES (structural stability, technological adequacy and policy support) on innovation performance via KA.

5. Discussion and conclusions

The extreme market competition and uncertainty of innovation urge enterprises to shift attention from traditional strategic cooperation models to the IE. Numerous global leaders, such as iPhone, Alibaba, Siemens and Philips, have built an IE centered on existing technologies and business models and formulated relevant innovation cooperation strategies (Iansiti and Levien, 2004a, 2004b). Nevertheless, the challenges accompanying innovation focus on the innovation paradigm within the IE, and the overall instability of the IE is a key issue restricting enterprises' innovation capabilities (Adner, 2017; Emily *et al.*, 2019). In this context, according to the knowledge-based theory, this study validates and reveals the path and mechanism of the effect of IES on innovation performance by introducing the moderated mediating variable KA and analyzing the moderated effect of unabsorbed slack. We argue that IES can enhance innovation performance by influencing KA. Therefore, this study provides a new theoretical framework for examining the relationship between IES and innovation performance from the perspective of knowledge.

This study provides objective support for the positive relationship between all three dimensions of IES, structural stability, technological adequacy and policy support and innovation performance, through data analysis. Therefore, when IE in which enterprises are located is relatively stable, they will show stronger innovation ability because they have lower transaction costs, faster innovation response speed and higher innovation risk tolerance. The test results of *H1* are consistent with previous research findings that a stable network structure contributes to enterprises' innovation performance (Kumar and Zaheer, 2019); that a sufficiently strong technological base among collaborating agents can make their collaborative innovation process smoother (Chen and Xie, 2018); that government subsidies facilitate sustainable innovation by enterprises (Song *et al.*, 2022). However, some scholars believe that the external network stability of enterprises will lead to cooperation locking and the decline of innovation vitality (Hasan and Koning, 2019; Lin *et al.*, 2022), which contradicts our findings. We argue that this is because IE as a unique network structure has its particularity. This study elaborates on the characteristics of IE, suggesting that IE is open and dynamic. Owing to the existence of a great quantity of complementary and random interconnected elements in the ecosystem, innovation subjects can flexibly and continuously integrate and restructure activities, assets and capabilities to prevent the emergence of innovation obstacles (Adner, 2006; Williamson and Demeyer, 2012).

This study dissects the relationship between IE and enterprises' innovation performance from the perspective of KA, thus explaining the flow and operation of knowledge resources, and responds to the call for address the value capture and knowledge transfer mechanisms in the IE (Emily *et al.*, 2019; Yaghmaie and Vanhaverbeke, 2020). The results show that *H2* is supported, which is consistent with previous research findings that enterprises are more likely to build trust with other innovation subjects when they are in the stable IE, thus enhancing KA efficiency (Yang *et al.*, 2019); that technological proximity is required for the identification and absorption of new knowledge between partners (Chen and Xie, 2018); that government R&D funding can reduce enterprises' innovation costs and risks, making enterprises more willing to engage in KA and technological innovation (Boeing, 2016). The importance of knowledge for enterprises is widely recognized (Del Giudice *et al.*, 2010, 2011). *H3* is supported, that is, KA is conducive to innovation performance, which is in line with Hämäläinen and Inkinen (2019) and Wolf *et al.* (2022), echoing Lei *et al.* (2019)'s call to strengthen innovation research in the Chinese context.

Most studies have singularly focused on the impact of external network resources or an enterprise's existing resources on its innovation performance without combining them (Tang, 2016; Vătămănescu *et al.*, 2020). This study fills this gap by emphasizing the important situational role of unabsorbed slack in the mediating process of KA derived from a moderated mediation model, more clearly explaining how the relationship of "IES—KA—IP" varies with the amount of unabsorbed slack. On the one hand, we study the interaction between external factors (IES) and internal factors (unabsorbed slack) to better clarify what kind of complex external environment and internal conditions can better promote KA behavior of enterprises. The results confirm *H4*, finding that abundant unabsorbed slack diminishes enterprises' taking advantage of the strong stability of IE in which they are embedded, and enterprises are unable to be efficient and accurately acquire multiple sources of external knowledge, consistent with the perspective of the agency theory (Kim and Lee, 2008). Specifically, innovation achievements can be obtained through the process of enterprise transformation and utilization of heterogeneous knowledge obtained from the external ecological environment (Li and Gao, 2021), which depends on the unabsorbed slack owned by the enterprise. In a stable IE, compared with enterprises with abundant unabsorbed slack, enterprises with less unabsorbed slack are more concerned about the use and allocation of redundant resources due to their resources and financial constraints and are more cautious in the selection of KA channels and types. In this case, a stable IE can help enterprises improve the accuracy and effectiveness of KA, thus enhancing the effect of innovation, i.e. KA transmits the positive effects of IES on innovation performance of enterprises more strongly. This finding identifies the boundary condition for the influence mechanism of IES on innovation performance.

5.1 Theoretical contribution

This study mainly has three theoretical contributions. First, this study expands the research vision of enterprise external network and innovation theory. Previous research has focused on exploring the significance of strategic alliances (Jiang *et al.*, 2018; Kumar and Zaheer, 2019), industrial clusters (Wu *et al.*, 2021) and other forms of enterprises' external networks for their innovation; there is still a lack of research on the IE, which has just emerged in China in recent years. This study discusses the nature and characteristics of the IE, trying to dissect its specificity and its mechanism of influence on innovation. Second, rather than viewing IES as a broad concept, we consider it a three-dimensional structure that encompasses structural stability, technological adequacy and policy support, which enriches the study of the IE. This provides an effective path reference for the healthy and orderly operation of IE and enables a more nuanced understanding of the relationship between IES and innovation performance. Additionally, few studies have discussed the role of IES in enhancing enterprise innovation performance based on a knowledge perspective. This study tests the applicability of the knowledge-based theory in the context of IE, and also provides a merit theoretical framework for uncovering the "black box" of the process mechanisms by which IES acts on innovation performance. Finally, this study innovatively introduces the moderating variable of unabsorbed slack and focuses on the role of nonknowledge unabsorbed slack, further enhancing the understanding of the process of KA by taking into account the enterprise's internal and external resources.

5.2 Management enlightenment

Our study also offers some suggestions for management practice. As builders of an IE, managers should attract as many innovation subjects in different industries as possible to improve the diversity of innovation species, ensure the stability of ecosystem structure and establish an information interaction platform to enable innovation subjects to access information quickly and accurately. The participants of an IE should strengthen interactions with customers, research institutions, universities, partners, financial institutions, government departments and other members of the IE, and enhance the trust between innovation subjects by conducting regular strategic dialogues, formulating responsibility allocation mechanisms and designing risk-sharing mechanisms (Sankowska and Paliszkiewicz, 2016). In addition, the technological distance between innovation subjects should be narrowed. Establishing technological alliances, building technological innovation cooperation platforms and conducting regular technological talent exchange activities can help enterprises to quickly adapt to technological innovation and improve the response speed of innovation (Cohen and Levinthal, 1990; Marrocu *et al.*, 2013). Relevant government departments and policymakers should implement talent introduction policies, innovation cooperation support policies and preferential tax policies to improve the stability of the IE and enhance innovation benefits. Additionally, managers must consider that it is not enough to focus on the external IE; they must also pay attention to aligning the unabsorbed slack within enterprises. We believe that when enterprises are in an IE with high stability, they should strategically avoid hoarding unabsorbed slack, and design corresponding management systems to restrict the managers' agent problem to prevent the loss of KA and innovation efficiency.

5.3 Limitations and future research

Although we fulfill part of the existing theoretical gaps, there are still certain limitations, which can be further studied. First, the sample data was mainly collected through questionnaires. Although we have excluded 104 invalid questionnaires, the data still inevitably have a certain degree of subjectivity. Future studies will combine first-hand data, such as questionnaires and interviews, and second-hand data, such as patents and innovative products' sales, to further enhance the credibility of the findings. Second, the survey sample of this study is drawn from only five regions with outstanding innovation capacity in China, and the research environment is also based on China's specific economic policy background. Therefore, whether IES will continue to exhibit an evident role in innovation performance in other national environments or other Chinese cities with less developed levels of innovation remains to be further explored. Finally, due to the complexity of data processing, this study does not provide a detailed division of innovation performance, such as radical innovation and incremental innovation. Future research can specifically investigate how IES affects different types of innovation, as well as whether differences impact paths and the intensity of IES.

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Appendix

Structural stability of an innovation ecosystem (IE)

- The degree of interdependence between my enterprise and other innovation subjects in terms of product and service innovation is large.
- The degree of interdependence between my enterprise and other innovation subjects in terms of management and operation innovation is large.
- In the IE where my enterprise is located, the distribution of innovation subjects in primary, secondary and tertiary industries varies greatly.
- In the IE in which my enterprise is located, the innovation subjects in the same industry differ greatly in their main business.

Technological adequacy of an IE

- In the IE where my enterprise is located, when a certain innovation subject has technological innovation, other innovation subjects can timely adapt to its technological innovation.
- In the IE where my enterprise is located, all innovation subjects can integrate the new technology with the old technology well.
- The IE where my enterprise is located attaches importance to the construction of “an innovation information interaction platform.”
- The “innovation information interaction platform” built by the IE where my enterprise is located is highly networked and digitalized.

Policy support of an IE

- The government attaches importance to the construction and development of the IE (e.g. setting up special departments for promotion, etc.).

- The government supports the innovation of each innovation body (e.g. introduction of tax incentives, preferential loan policies, etc.).
- The government attaches importance to the construction of innovative talent teams (e.g. introducing policies on the introduction of talents, etc.).

Knowledge acquisition

- My enterprise can learn technological knowledge from other innovation subjects.
- My enterprise can learn managerial knowledge from other innovation subjects.
- My enterprise can learn production knowledge from other innovation subjects.
- My enterprise can learn marketing knowledge from other innovation subjects.

Unabsorbed slack

- My enterprise has a pool of financial resources that can be used on a discretionary basis.
- My enterprise has sufficient retained earnings (such as undistributed profits) for market expansion.
- My enterprise can secure bank loans or other financial support when needed.

Innovation performance

- Compared with the industry average, the number of new products of my enterprise is more.
- Compared with the industry average, the ratio of new product sales to total sales of my enterprise is significant.
- Compared with the industry average, the speed of new product development and marketing of my enterprise is fast.
- Compared with the industry average, the success ratio of product innovation of my enterprise is high.

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