

Impact of the latecomer's ambidextrous innovation catch-up on the performance of technical standards alliance from the perspective of alliance routines



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ABSTRACT

Joining a technical standards alliance is becoming increasingly crucial for latecomer enterprises' innovation catch-up in today's fast-paced technological environment. This study investigates the influence of latecomers' ambidextrous innovation on technical standards alliances while highlighting the importance of alliance routines. A structural equation model is used to analyse a sample of 118 latecomer members and 45 technical standards alliances in China's strategic emerging industries. Several novel findings are reported. First, latecomers' two types of innovation catch-up and the three dimensions of alliance routines promote alliance performance, all of which positively impact alliance performance. Second, alliance routines have different effects on latecomers' Ambidextrous innovation catch-up. All three dimensions of the alliance routine promote utilisation innovation catch-up, whereas behavioural logic and interactive consensus hinder exploration innovation catch-up. Third, utilisation innovation completely mediates between alliance practice and performance, whereas exploration innovation only plays a partial mediating role. This study presents specific recommendations for latecomer enterprises and technical standards alliances.

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Introduction

The current industrial innovation landscape is transitioning from the conventional closed innovation model to the contemporary open innovation paradigm as a novel avenue for collaboration. The formation of technology standards alliances has emerged as a pivotal driver for reshaping industrial structures and enhancing enterprises' innovative capacities. Noteworthy examples include the establishment of GSM (Global System for Mobile Communications) and WCDMA (Wideband Code Division Multiple Access) alliances within the communications sector and the 6C, 3C, and Bluetooth alliances in the computer and multimedia industries. These alliances consolidate top-tier resources (Su, Hu & Wang, 2022), such as talent, knowledge, technology, and brands within the industry (Li, 2014). Consequently, technology standards alliances have emerged as pivotal strategic mechanisms for enhancing enterprises' innovation capabilities and

making sound technological innovation and risk management decisions.

Within technology standards alliances, one can find not only industry-leading enterprises but also a significant number of latecomer enterprises. The former typically serves as an alliance's driving force and backbone, garnering increasing attention in academic circles. The latter are relatively few, characterised by lagging technology and market presence. Despite their perceived shortcomings, latecomers' innovation efforts are crucial in shaping the trajectory of technology standards alliances. This study sheds light on the significance of latecomer enterprises in alliances.

In their quest to catch up innovation-wise, latecomer enterprises exhibit ambidextrous characteristics. These enterprises adopt two catch-up strategies: exploration and utilisation innovation (Peng, Zheng & Wu, 2017). The existing literature primarily focuses on analysing how to effectively carry out discontinuous exploration innovation in technology and knowledge to achieve significant advancements in the performance of innovative products. However, utilisation innovation, a more general and widespread form of innovation, plays a crucial role in sustaining a firm's existing product market and reducing the technological gap between enterprises (Zhang, Quah & Nor, 2023). Hence, this study investigates the separate

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impacts of exploration and utilisation innovation on alliance performance in latecomer enterprises. By doing so, we can ascertain differentiated outcomes and gain a comprehensive understanding of the subject matter.

Enterprise alliances are characterised by the prevalence of alliance routines, which play a vital role in understanding the activities of alliance members and the overall functioning of alliances (J. Y. Wen, Qualls & Zeng, 2020). These routines reflect the behavioural patterns and consensus norms that develop amongst members through repeated interactions. These elements are crucial for maintaining and coordinating strategic alliances (Jiang, Liu & T, 2019). Moreover, alliance routines serve as indicators of the level of trust and integration within inter-organisational networks. The influence of different types of routines on enterprise innovation activities varies by promoting or hindering overall innovation outcomes (García-Canal, Valdés-Llaneza & Sánchez-Lorda, 2014). Therefore, it is imperative to delve deeper into how alliance practices influence the ambidextrous innovation efforts of latecomer enterprises and alliance performance.

This study situates latecomer enterprises within the framework of alliance routines. It examines the intricate relationship between alliance routines, ambidextrous innovation catch-up within latecomer enterprises, and the performance of technology standards alliances. Doing so, it contributes to a deeper understanding of ambidextrous innovation and late-mover advantage theories. It also sheds light on the pathway to establishing a mutually advantageous scenario: fostering the rapid growth of latecomer enterprises while ensuring the sustainable development of technology standards alliances.

The remainder of this paper is organised as follows. Section 2 presents the theoretical foundation hypotheses, while Section 3 describes the data collection and variables employed in the study. After addressing the empirical research, Section 4 presents the results, and Section 5 discusses the contribution, implications, and the study's conclusions. Finally, Section 6 addresses research limitations and future research directions.

Related literature and hypothesis development

Theoretical background

In the realm of technology standards alliances, both domestic and international, existing research predominantly originates from the strategic alliance framework. Examining the organisational structure of these alliances, Zhang and Zhang (2007) posit that technology standards alliances fundamentally consist of interconnected licencing agreements, representing a typical contractual alliance structure. Delving into patent licencing, Yu, Dai, Xu and Ye (2023) highlight that technology standards alliances serve as organisational vehicles in which owners of multiple patents or technologies converge their proprietary innovations into technical standards through collaborative technology sharing, enforcing standardised patent licencing practices. Regarding the core objectives of these alliances, Hemphill (2005) emphasises that technology standards alliances are strategic coalitions established by companies with the shared goal of standards formulation, with the overarching aim of advancing technical standards research and enhancing value accumulation. Building on these insights, this study posits that technology standards alliances manifest as collaborative entities formed by multiple enterprises driven by strategic imperatives to collectively develop technical standards and promote widespread adoption in the market. Regarding alliance composition, guided by the resource dependence theory, only companies with substantial operational capabilities and resources can effectively pursue exclusive standardisation strategies. Hence, latecomers lacking the requisite core technologies and patents for standard development are prompted to participate in technology standards alliances (Wang, Kwak & Lee, 2014). Most members of technology standards alliances are latecomers.

In the context of a technical standards alliance, a latecomer is defined as a member of the alliance that overcomes the dual disadvantages of technology and the market and participates in competition for catch-up purposes. The catch-up of capabilities is the key to implementing a catch-up strategy (Jiang, Gong & Wei, 2011). Previous studies mainly emphasise the accumulation of technical and market capabilities but ignore the fact that the practice of enterprises has gradually shifted to catching up with innovation capabilities (Liu, Wei & Jiang, 2013). Latecomers need to become innovators rather than imitators to “catch up” rather than “keep up” (Chang, Chung & Mahmood, 2006), which challenges the dominant imitation-to-innovation paradigm. When approaching the technological frontier, latecomers may either only leapfrog from “catch-up” to “leader” or fall into the “catch-up trap,” repeating the cycle of “catch-up - lag - catch-up” (Lee & Malerba, 2017). What innovation strategies should latecomers adopt to build their innovation capabilities and become industry leaders? Ambidexterity theory provides a good answer: the ambidextrous innovation catch-up strategy, which includes exploration and utilisation innovation. The former is a disruptive innovation that aims to develop new products or markets beyond existing knowledge, whereas the latter is a progressive innovation that improves and elevates products and processes based on existing knowledge. In the process of innovation, latecomers must engage in continuous learning and communication in order to acquire new knowledge and technology. This involves not only interactive communication within the enterprise but also collaboration and resource-sharing with other members of the alliance, a practice influenced by the routines within the alliance (Zhou, Wen & Yang, 2023).

Feldman and Pentland (2003) introduce a comprehensive two-dimensional perspective on organisational routines, which comprises the ostensive aspect embodying the fundamental principles of routines and the performative aspect encompassing the spontaneous attributes of actors. Building upon this ambidextrous perspective, this study delves into the dynamics of technology standards alliances. It asserts that the ostensive aspect of such alliances signifies factual regulations that serve as potential routines guiding members. These regulations include implicit norms and an interactive consensus. In contrast, the ostensive aspect consists of members' behaviours, representing specific operational methods within the work process, also known as behavioural logic. Hence, routines within a technology standards alliance may be defined by implicit norms, interactive consensus, and behavioural logic. Implicit norms refer to the unspoken rules agreed upon collectively by members or tacit knowledge embedded within the alliance. Interactive consensus pertains to a shared understanding and collective beliefs established through cooperation and mutual learning. These aspects address the question of “why it is done.” In addition, behavioural logic elucidates the “how” behind these actions.

Hypothesis development

Alliance routines and technical standards alliance

The emergence of alliance routines is a gradual process shaped by interactions and exchanges amongst the members of technology standards alliances in their cooperative endeavours (Hoang & Rothaermel, 2005). Establishing mature and stable practices is crucial in aligning standardisation cooperation across enterprises, mitigating the tension between member autonomy and the alliance's cohesiveness, and bolstering the alliance's stability for smooth operations. This practice, in turn, contributes significantly to enhancing the performance of standard technology alliances. Examining the impact of conventions on the performance of technology standards alliances within the context of group standardisation processes reveals insights across three dimensions.

In the nascent stages of technology standards alliance formation, member interactions are akin to a period of trial and error. Rather

than navigating uncertainties independently, such as novices, members adapt established behaviour models from experienced enterprises in the realm of standardisation. This strategic emulation substantially reduces the costs associated with inter-organisational collaboration and enhances problem-solving efficiency. The resulting code of conduct facilitates the progression of member relationships from disordered to orderly, fostering an atmosphere conducive to cooperation.

A consensus on implicit alliance norms gradually emerges as collaboration matures through members' mutual adjustments and problem-solving approaches (Cheng, Dang & Yang, 2018). These norms serve as guiding principles, regulate members' conduct, steer their actions in fulfilling responsibilities, nurture and sustain inter-organisational ties, and fortify the stability of standards alliances (Xiao & Dang, 2018). Simultaneously, these implicit norms shape members' expectations regarding cooperative behaviours, foster trust amongst participants, diminish the coordination and transactional expenses entailed in alliance activities, and underpin the effective progression of collaboration amongst members.

The primary objective of technology standards alliances is to establish and enforce standards. Before the endorsement and publication of a draft standard as an official document, a consensus must be reached amongst the alliance members. This process of interactive consensus deepens the comprehension and unspoken agreement amongst alliance members, establishing a robust emotional groundwork for resolving potential discrepancies related to standard terminologies and technical parameters. Furthermore, interactive consensus plays a pivotal role in providing a stable conduit for the exchange of knowledge, information, and technology pertinent to standards, ultimately diminishing information disparities (Zollo & Winter, 2002) and fostering unity amongst members. Moreover, standards widely accepted by members tend to be extensively implemented within a cohort.

The tripartite facets of alliance norms play a crucial role in enhancing the efficacy of technology standards alliances, substantiating the following hypotheses:

H1. Alliance routines positively affect alliance performance.

H1a. Behavioural logic positively affects alliance performance.

H1b. Interaction consensus positively affects alliance performance.

H1c. Implicit norms positively affect alliance performance.

Alliance routines and ambidextrous innovation catch-up

From an organisational learning perspective, utilisation exploration by latecomers refers to improvements, adjustments, or extensions based on existing abilities and technological development trajectories (Xu, Zhang & Zheng, 2020). Technology standards alliances are a potential avenue for latecomer learning. Functioning as an internal force that sustains the existence and orderly operation of the alliance, routines facilitate the effective flow of knowledge and information between latecomers and other members. As a means of coordination, routines are often more effective than contracts. They facilitate regular communication and sharing mechanisms amongst alliance members, enhancing the frequency and depth of partner interaction. Doing so, they help mitigate opportunistic behaviour and speculative risks while reducing transaction costs (Berente, Lyytinen, Yoo & King, 2016). Moreover, mature and stable routines enable latecomers to acquire innovative knowledge from the network by adhering to established practices, eliminating the need for excessive search and cognitive costs within the organisation.

The catch-up of latecomers to exploratory innovation necessitates a diverse and novel knowledge base. However, the path-dependant nature of routines hinders the establishment of extensive relational resources, impedes the transfer and acquisition of diverse and heterogeneous knowledge, and subsequently traps enterprises within a

“capacity trap” (Cohendetp & Simon, 2016), hindering their exploration innovation. Hence, exploratory innovation should not be limited to breaking through existing technological trajectories; it should also challenge established learning behaviours and paradigms. Inertia, rooted in previous behaviour patterns, influences latecomers' decision-making processes, leading to the formation of “muscle memory,” which restricts their innovative conduct. As alliance routines become more advanced, members increasingly rely on existing communication channels, limiting themselves to information related to the established norms and models. Consequently, they lack a shared understanding of new ways of thinking and behaviour, impeding the generation of breakthroughs and disruptive innovations. Based on these considerations, this study proposes the following hypotheses:

H2a. Alliance routines have a negative effect on exploration innovation catch-up.

H2b. Alliance routines have a positive impact on utilisation innovation catch-up.

(1) Behavioural logic and ambidextrous innovation catch-up.

Behavioural logic within technology standards alliances embodies “the collective *modus operandi* of the alliance,” derived from past alliance practices or the operational model adopted by industry leaders. Utilisation innovation by late-coming enterprises predominantly underscores the enhancement and application of existing knowledge frameworks. Behavioural logic imparts latecomers with a blueprint on “how to navigate challenges,” enabling them to craft appropriate responses in similar scenarios and consequently boosting innovation efficiency. As a by-product of experimental learning, behavioural logic serves as a repository of experiences (Pentland, Feldman, Becker & Liu, 2012), providing latecomers with insights into the determinants of success or failure. Behavioural logic supplies latecomers with a springboard to capitalise on the achievements of industry giants, facilitating their continued advancement along the established technical trajectory. Nonetheless, the adoption of behavioural logic amplifies latecomers' reliance on other alliance members, potentially dampening their inclination to seek new partnerships. In contrast to other alliance formats, members of standards alliances are predominantly hailed from the same industrial sphere. Consequently, behavioural logic impedes enterprises from promptly assimilating crucial knowledge and novel ideas from disparate fields (Angwin, Paroutis & Connell, 2015), which serve as indispensable technical reservoirs for technological advancement. Conventional behavioural and convergent thought patterns instilled by behavioural logic often instigate path dependency, constraining innovative ideation. Breakthrough innovations typically manifest when new avenues are forged that deviate from conventional paths. As a result, behavioural logic hinders latecomers' breakthrough innovations. Based on these considerations, we propose the following hypotheses:

H2.1a. Behavioural logic has a negative effect on latecomer firms' exploration innovation catch-up.

H2.1b. Behavioural logic positively affects latecomers' utilisation of innovation catch-up.

(2) Interaction between consensus and ambidextrous innovation catch-up.

Interactive consensus has two distinct connotations: communication and exchange amongst members and collective cognition. The former fosters trust within an alliance, enriches cognition and comprehension amongst members, and establishes a solid emotional foundation for inter-organisational learning. Technological innovation is a means of inter-organisational learning and facilitates the steady accumulation of knowledge. Interactive consensus encourages members to engage in open dialogues and share their experiences and insights.

This approach promotes rapid dissemination of explicit and tacit knowledge within the alliance, ultimately driving incremental innovation. However, intensive communication and collaboration can result in the emergence of structural holes and redundant connections within the latecomer network. Consequently, the flow of information within this network tends to be homogeneous, leading to cognitive cost reduction due to the reliance on homogeneous knowledge. This phenomenon can foster cognitive laziness amongst enterprises, diminishing their exploration of heterogeneous knowledge and weakening their capacity for exploratory innovation (Hu, Wang, Liu & Song, 2022).

Interactive consensus enhances the understanding and empathy of latecomers, allowing them to internalise novel and valuable knowledge from the alliance. This process facilitates the improvement or upgrading of original product designs and process technologies, fostering innovation in utilisation. Simultaneously, by establishing a shared technical language, consensus, and tacit understanding minimise disparities between alliance members and internal personnel, thereby enhancing the efficiency of enterprise utilisation innovation (Lin & Shang, 2017). Nevertheless, standards are developed based on a consensus amongst members and are subsequently utilised and reused. Hence, it is not essential for a consensus within a technology standards alliance to encompass the most advanced or cutting-edge elements. To expedite the efficiency of standard formulation and promote the marketisation of standards, it is crucial to recognise that consensus does not solely revolve around cutting-edge advancements. Furthermore, within a technology standards alliance, member interactions predominantly revolve around standards rather than technical cooperation. Compared to technical collaboration, standards cooperation tends to be restricted in scope and is characterised by homogeneous exchanges. This cognitive framework presents a potential obstacle to the breakthrough innovations of latecomers. Hence, we propose the following hypotheses:

H2.2a. Interaction consensus has a negative effect on latecomers' exploratory innovation catch-up.

H2.2b. Interaction consensus positively affects latecomer firms' utilisation of innovation catch-up.

(3) Implicit norms and ambidextrous innovation catch-up.

On the one hand, implicit norms have a coordinating role, which can effectively control alliance members' behaviours and cooperation processes, maintain and improve the relationship between cooperative parties, and ensure the orderly operation of the innovation network (Sun et al., 2020); on other hand, they have a stabilizing role, which improves the predictability of alliance members' decision-making, and promotes members' sharing, dissemination, and acquisition of new technological knowledge. Indeed, within the realm of enterprise innovation, the presence of implicit norms is indispensable because nothings can be achieved without norms and standards. It is through the adherence to implicit norms that fruitful collaborations and the ambidextrous innovation of enterprises, flourish within the alliance context. Implicit norms, forged through shared understanding and normative consensus developed during interactions and communications amongst members, represent a reservoir of valuable knowledge assets, akin to organisational memory.

As products of collective learning, implicit norms empower members to effectively leverage, preserve, evolve, and adapt organisational knowledge. Mature and stable implicit norms enable organisations to acquire the required innovative knowledge from standards only by following agreed-upon routines, which not only saves a lot of time and effort, but also reduces the search and cognitive costs of the organisation (Guan et al., 2019). Moreover, the function of coordinating and stimulating the interaction of knowledge that routines have can make the transfer of knowledge more fluid and orderly, avoiding the

risks of opportunism and speculation and reducing transaction costs. Therefore, implicit norms have a significant facilitating effect on both exploration and utilisation innovations.

H2.3a. Implicit norms positively affect latecomer enterprises' exploration innovation catch-up.

H2.3b. Implicit norms positively affect latecomer firms' innovation catch-up.

Ambidextrous innovation catch-up and alliance performance

A technology standards alliance is an organisation involving enterprises as key participants aimed at conducting collaborative standardisation endeavours. At their core, alliance standards represent de facto standards established through market mechanisms. In contrast to government-formulated standards, de facto standards are competitive and proprietary. The genesis of alliance standards lies in the technical innovation spearheaded by its members, rendering standards competition a technical contest. Enterprises engage in exploratory innovation and foster the development of cutting-edge technologies and products while venturing into new market territories. By mastering ground-breaking technologies that are not easily reproducible, enterprises take the lead, dictate technological directions, and uphold a competitive edge. De facto standards are then developed based on these technologies, seizing control of nascent markets (Adamides & Karacapilidis, 2020). While utilisation innovation within enterprises involves incremental modifications and continuous enhancements to existing technologies and products catering to prevalent market demands (Li, Liu & Boadu, 2023), the self-reinforcing mechanism driven by positive feedback from standards, enhancing market-specific standards solidifies their dominance in technology and product landscapes tethered to market-scale benefits. The market is the ultimate arbiter of successful technological innovation outcomes and standards. To promote the adoption of standards, a technical standards alliance endeavours to attract many enterprises, particularly those joining the fray at a later stage. By definition, a standard denotes a unified technical specification within a domain. Hence, standard development adheres to the "barrel theorem" principle - the capacity of a barrel to hold water hinges not on its longest stave but on the shortest one. As a proverbial short stave in the barrel of the technical standards alliance, latecomers are compelled to urgently enhance their technical prowess to foster consensus amongst members and elevate the technical calibre of standards. In summary, the ambidextrous catch-up innovation efforts of latecomers galvanise the efficacy of the technical standards alliance. Hence, we propose the following hypotheses:

H3. Ambidextrous innovation catch-up has a positive effect on alliance performance.

H3a. Exploration innovation catch-up has a positive effect on alliance performance.

H3b. Utilisation innovation catch-up has a positive impact on alliance performance.

Mediating role of ambidextrous innovation catch-up

Recent research has argued that organisational routines are highly contingent, meaning that their formation and evolution are the outcome of the collaborative efforts of participants in specific situations (Pentland, Haerem & Hillison, 2011). Within technical standards alliances, these routines influence alliance performance by shaping members' innovation activities. Routine implementation, often characterised by a "learning by doing" approach and the learning curve effect, fosters a learning process for alliance members. This process contributes to developing a collective innovation atmosphere within

the alliance and enhances the overall effectiveness of technical standardisation. [Rerup and Feldman \(2011\)](#) highlight that trial-and-error learning and exploratory innovation effectively bridge organisational practices and foster organisational innovation. Moreover, it is essential to recognise that group standards, in contrast to government-led standards, such as national and industry standards, are market-driven and place significant emphasis on advanced technology and market applicability. Consequently, latecomers face limitations regarding their contribution to and impact on group standardisation due to technological and market disadvantages. Nevertheless, alliance routines have the potential to act as precursors, positively influencing latecomers' alliance performance through technological innovation. Alliance routines enhance enterprises' research and design (R&D) efficiency and technical capabilities by providing tacit knowledge and an innovative paradigm. Consequently, latecomers can establish a common understanding concerning technical standards with other alliance members, including leading enterprises. This shared understanding accelerates the standards formation process within the alliances. Based on these considerations, we propose the following hypotheses:

H4. Ambidextrous innovation catch-up mediates the relationship between alliance routines and firm performance.

H4a. Exploration innovation catch-up mediates the relationship between alliance routines and firm performance.

H4b. The utilisation of innovation catch-up plays a mediating role between alliance routines and performance.

Fig. 1. depicts the conceptual model used in this study.

Research design

Data collection

Our study focuses on technology standards alliances within China's strategic emerging industries. The selected sample comprised 45 technology standards alliances from various sectors, including new energy, new-generation information technology, new materials, and high-end manufacturing industries. We investigated 118 latecomers. Initially, we conducted a preliminary survey involving 12 technology standards alliances, specifically examining five. A combination of open-ended, semi-structured interviews and telephone discussions was employed to gather the relevant data. The information collected primarily focused on the enterprises' innovation activities and performance and the standards alliance's practices and development. The final questionnaire used in this study comprised two sections. The first section was designed to gather information on a technology standards alliance, encompassing its fundamental characteristics, alliance routines, and performance. Managers responsible for overseeing the technology standards alliance completed this questionnaire section. The second section collected information on

latecomer enterprises, encompassing their basic information and approaches to ambidextrous innovation catch-up. Managers representing the top management, technical, and standardisation departments within each enterprise completed the questionnaire. After successfully matching the two completed questionnaires, a consolidated and comprehensive questionnaire was obtained for the analysis. Three hundred seventy-two questionnaires were collected, 258 of which were deemed valid, resulting in an effective questionnaire response rate of 69.35%.

Variable measurement

This study measured three variables: alliance routines, performance, and ambidextrous innovation catch-up. Existing, well-established scales at home and abroad were used, with some modifications, based on the research content of this study. Each variable was measured using a Likert five-point scale, ranging from "1" = very non-compliant and "5" = very compliant.

Dependant variables

Drawing on [Wang, Wang and Shao \(2019\)](#) and [Li, Wang, Wang and Wang \(2022\)](#), 10 question items measure the three dimensions of alliance routines, including behavioural logic, implicit norm, and interactive consensus, which are shown in [Table 1](#).

Table 1
Alliance routines scale.

Variable	Dimensions	Items
Alliance routines	Behavioural logic	1. Alliance cooperation offers lessons to be learned for businesses 2. Alliance cooperation provides businesses with referenceable procedures and solutions to problems 3. Ability to consciously agree on specific actions with partner companies
	Interactive consensus	1. Over time, alliance partners can accurately understand each other's intentions 2. Over some time, a series of organisational processes have evolved amongst the alliance partners 3. Through a period of cooperation, alliance partners have reached a tacit understanding in their dealings 4. Through a period of cooperation, tacit understanding amongst alliance partners guides their behavioural choices
	Implicit norms	1. Implicit rules exist within the alliance that define the objectives of the mission 2. Implicit norms exist within alliances that constrain cooperative behaviour 3. The members of the Alliance can develop a deeper understanding and consensus on these rules and norms in the course of their cooperation

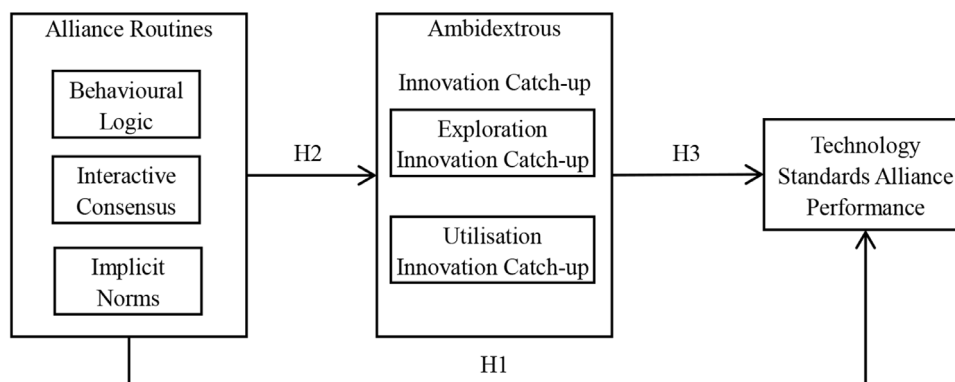


Fig. 1. Conceptual model.

Table 2
Alliance performance scale.

Variable	Items
Alliance performance	1. The alliance quickly releases new standards.
	2. The number of patents in alliance enterprises is constantly increasing.
	3. The standards of the alliance are widely applied in the market.
	4. The new product revenue of alliance enterprises continues to rise.
	5. The success rate of new product development in alliance enterprises is relatively high.

Independent variable

Currently, there is no consensus amongst scholars on how to measure the performance of technology standards alliances. Broadly speaking, there are two main approaches. One approach adapts performance measurement methods from strategic alliances and business alliances, focusing on quantifying the achievement of financial indicators. The other approach, more tailored to the unique nature of technology standards alliances, gauges performance through innovation, a key resource within such alliances. As previously discussed, technology standards alliances typically do not interfere with their members' business operations but rather establish and uphold rules that govern interactions amongst technology owners, standard setters, and users. Thus, viewing a technology standards alliance solely as a trading or distribution hub oversimplifies its role, as it also serves as a platform for collaboration, rendering traditional financial metrics inadequate for evaluating its performance.

This study builds upon existing research on "alliance performance" (Russo & Vurro, 2029; J. Wen, Qualls & Zeng, 2020) and "Innovation Performance" (Jiang, Wang, Gao, Chen & Sheng, 2023), emphasizing the unique characteristics of technology standards alliances, namely, the formulation and implementation of new technical standards. It proposes a performance measurement framework comprising five key indicators, as illustrated in Table 2.

Intermediate variables

Drawing on the relevant scale settings of Farjoun (2010), Rui and Luo (2019) and Srisathan, Ketkaew and Naruetharadhol (2023), with some modifications based on the research context, this study measures both exploration innovation catch-up and utilisation innovation catch-up using five-question items to measure exploration innovation catch-up and utilisation innovation catch-up, as shown in Table 3.

Control variables

To control for the influence of other factors on firms' innovation outcomes, we selected three control variables: firm age, firm size, and R&D investment. Firm age refers to the time of firm

Table 4
Reliability and validity analysis.

Dimensions	Item number	Factor payloads	Cronbach's α	CR	AVE
Behavioural logic	1	0.876	0.904	0.906	0.763
	2	0.931			
	3	0.810			
Interactive consensus	1	0.747	0.800	0.804	0.508
	2	0.756			
	3	0.726			
	4	0.612			
Implicit norms	1	0.820	0.837	0.837	0.632
	2	0.799			
	3	0.765			
Alliance performance	1	0.763	0.806	0.887	0.619
	2	0.902			
	3	0.513			
	4	0.828			
	5	0.865			
Exploration innovation catch-up	1	0.760	0.817	0.841	0.521
	2	0.892			
	3	0.687			
	4	0.552			
	5	0.674			
Utilisation innovation catch-up	1	0.739	0.766	0.848	0.529
	2	0.795			
	3	0.763			

establishment; older firms usually have more experience and performance advantages (Chiesa, Coughlan & Voss, 1996). This study divided firm age into different levels for categorisation and analysis. Firm size refers to the resources and influence owned by the firm. Larger firms usually have more innovation opportunities and partners and are, therefore, more likely to diversify their innovations (Zhang, 2009). This study categorised and analysed the number of employees in a firm as a measure of its size (Shen, 2011). An enterprise's R&D investment refers to the resources invested in R&D activities, including the number of R&D personnel and the proportion of R&D expenditure to sales revenue. This study categorised R&D investment to eliminate the impact of different enterprises' R&D investments on innovation outcomes.

Empirical results

Reliability and validity analysis

As shown in Table 4, the results of the data analysis indicate that the reliability values (Cronbach's alpha) of all variables are greater than the baseline value of 0.7, and it can be assumed that the scale findings of this study have high reliability. The factor loadings of all items of the questionnaire are higher than 0.5, and the squared

Table 3
Ambidextrous innovation catch-up scale.

Variable	Dimensions	Items
Ambidextrous innovation catch-up	Exploration innovation catch-up	1. Our firm is constantly trying to develop and introduce new technologies in the industry.
		2. Our firm often tries to open up completely new markets.
		3. Our firm often tries to introduce new products and services.
		4. Our firm has achieved major breakthroughs through innovation.
		5. Our firm's technology development risk is relatively high.
	Utilisation innovation catch-up	1. Our firm regularly improves current technologies, products, and systems to meet current needs.
		2. Our firm routinely utilises technology already in use to increase the functionality and variety of existing products and services.
		3. The gap between Our firm and industry leaders in terms of process or production technology is getting smaller and smaller.
		4. Our firm is constantly refining its previously accumulated business experience to apply it to future business.
		5. Our firm's technology development risk is average.

Table 5
Correlation analysis results.

variable name	Age	Size	R&D investment	Behavioural logic	Interactive consensus	Implicit norms	Exploration innovation catch-up	Utilisation innovation catch-up	Alliance performance
Age	(0.697)								
Size	0.144*	(0.723)							
R&D investment	0.111	0.518**	(0.630)						
Behavioural logic	0.044	-0.144*	-0.183	(0.715)					
Interactive consensus	0.094	-0.111	-0.123	0.133**	(0.794)				
Implicit norms	0.104	-0.097	-0.082	0.124**	0.155**	(0.693)			
Exploration innovation catch-up	0.216**	-0.027	-0.011	-0.252**	-0.241**	0.279**	(0.608)		
Utilisation innovation catch-up	0.123	-0.057	-0.021	0.594**	0.482**	0.514**	0.095	(0.659)	
Alliance performance	0.229**	0.072	0.003	0.194**	0.161*	0.213**	0.124**	0.126*	(0.641)

Note:

** indicates significance at the 1% level.

* indicates significance at the 5% level, and the AVE square root is in diagonal brackets.

Table 6
Fitting coefficients of the overall measurement model.

Fitness index	χ^2/df	GFI	RMSEA	NFI	CFI
Model values	2.120	0.848	0.068	0.904	0.903
Reference values	<3.00	>0.80	<1.00	>0.80	>0.80

values of the variance extracted volume (AVE) between two by two for all variables are greater than the correlation coefficients between the variables, indicating that the validity of the scales also reached a high level.

Correlation analysis

Table 5 demonstrates the matrix of correlation coefficients, and the results show a significant correlation between the variables except for the control variables; the absolute value of the correlation coefficients is lower than 0.7, indicating no significant collinearity problem between the variables. The following conclusions can be drawn based on the correlation coefficients between the variables in the table. A significant correlation is observed between behavioural logic, implicit norms, interactive consensus, exploration innovation catch-up, and utilisation innovation catch-up. Meanwhile, we note a significant correlation between alliance performance and behavioural logic, implicit norms, interactive consensus, exploration innovation catch-up, and utilisation innovation catch-up. These results provide preliminary evidence that the hypotheses of this study are valid. However, it should be noted that the correlation can only reflect whether a relationship exists between the research variables and does not reveal the causal relationship or influence mechanism between the variables. To further confirm the relationship between

the variables, this study used structural equation modelling to test the hypotheses proposed in the previous section.

Model testing and results

Structural equation model (SEM) is a method for analysing causality models that can deal with unobservable variables (latent variables) and the relationship between multiple independent and dependant variables. Therefore, an SEM was used in this study to test the main effect hypothesis of H1-H3 with Amos software. The results of the fitting degree analysis of the SEM are shown in Table 6. $\chi^2/df=2.12$, less than three; RMSEA=0.068, less than 0.08; CFI=0.903, GFI=0.848, and NFI=0.908, which all exceed 0.8. The indices are all within the acceptable range; therefore, the main effects model fits well.

The path coefficients of the SEM and their test results are listed in Table 7. In the path between alliance routines and exploration innovation catch-up, the standardised path coefficients of the former's behavioural logic, implicit norm, and the latter are -0.265 and -0.194, respectively, while the former's interactive consensus and exploration innovation catch-up path coefficients are 0.221. The three dimensions of alliance routines significantly and positively influence utilisation innovation, with path coefficients of 0.395, 0.304, and 0.227, respectively. Hence, H2b is supported. The path coefficients of the impact of the three dimensions of alliance routines on alliance performance are positive at 0.043, 0.016, and 0.124. All three paths pass the significance test, supporting hypotheses H1a, H1b, and H1c. The standardised path coefficients of the impact of exploration innovation catch-up and utilisation innovation catch-up on alliance performance are 0.317 and 0.359, respectively, indicating that the ambidextrous innovation catch-up of latecomers improves alliance performance. Therefore, H3a and H3b are supported.

Table 7
Path coefficient estimation results.

Paths		Standardised coefficient	S.E.	C.R.	P
Exploration innovation catch-up	<— Behavioural logic	-0.265	0.149	-1.693	***
Exploration innovation catch-up	<— Interactive consensus	-0.194	0.161	-1.401	***
Exploration innovation catch-up	<— Implicit norms	0.221	0.049	1.281	***
Utilisation innovation catch-up	<— Behavioural logic	0.395	0.157	3.032	***
Utilisation innovation catch-up	<— Interactive consensus	0.304	0.154	2.275	***
Utilisation innovation catch-up	<— Implicit norms	0.227	0.106	1.785	***
Alliance performance	<— Behavioural logic	0.043	0.126	0.157	**
Alliance performance	<— Interactive consensus	0.016	0.185	0.039	**
Alliance performance	<— Implicit norms	0.124	0.025	0.912	***
Alliance performance	<— Exploration innovation catch-up	0.317	0.139	2.429	***
Alliance performance	<— Utilisation innovation catch-up	0.359	0.186	2.645	***

Table 8
Analysis of the mediating role of ambidextrous innovation catch-up.

Paths	Indirect effects		p	Bias corrected	
	Estimate	S.E.		Lower2.5%	Upper2.5%
Behavioural logic-exploration innovation-alliance performance	-0.084	0.47	0.101	-0.114	0.015
Interactive consensus-exploration innovation-alliance performance	-0.061	0.024	0.096	-0.108	0.023
Implicit norms-exploration innovation-alliance performance	0.070	0.052	0.025	0.068	0.130
Behavioural logic-utilisation innovation-alliance performance	0.142	0.061	0.001	0.017	0.336
Interactive consensus-exploration innovation-alliance performance	0.109	0.087	0.049	0.013	0.285
Implicit norms-exploration innovation-alliance performance	0.081	0.055	0.023	0.027	0.256

This study used the bootstrap method to examine the mediating effect of ambidextrous innovation catch-up. The sample implied 5000 iterations, and a 95% confidence interval (CI) was calculated. The mediating effect was considered significant if the CI did not contain zero. The results in Table 8 show that latecomers' utilisation innovation catch-up has a mediating effect on alliance routines and technical standards alliance performance; that is, the mediating effect between each path between the three dimensions and alliance performance does not include zero in the 95% CI. Thus, H4b is supported. The exploration innovation catch-up of latecomers only plays a partial mediating role in alliance routines and alliance performance. It has no significant mediating effects on paths of behavioural logic and alliance performance and implicit norms and the mediating effect because zero is comprised in the two confidence intervals. However, it mediates the path "interactive consensus-alliance performance" because its 95% confidence interval is [0.068,0.130]. Hence, H4a is not supported.

Theoretical contributions, practical implications, and conclusions

Theoretical contributions

First, this study is amongst the first to theoretically investigate latecomers in an alliance and enhance the scientific literature on the role and impact of latecomers' ambidextrous innovation. It empirically demonstrates that exploration and utilisation innovations within latecomer enterprises contribute significantly to improving the performance of technology standards alliances. Furthermore, the research findings indicate that the ambidextrous innovation within latecomer enterprises partially mediates the relationship between alliance protocols and outcomes. The findings also illustrate that network bricolage mediates the relationship between network ties and innovation performance. Prior research has predominantly focused on key industry players within standards alliances, disregarding enterprises' varying developmental stages. Limited attention has been paid to the analysis of latecomer enterprises in the literature.

Second, this study offers insights into resolving the paradox surrounding the relationship between standards and innovation in an academic context. The interplay between standards and technological innovation has been debated in scholarly discourse (Acker, 2014; Egyedi & Sherif, 2010; Grégoire-Zawilski & Popp, 2023; Wen, Forman & Jarvenpaa, 2023; Xu, Yang, Li & Shao, 2023; Yu, Qian & Chen, 2022). This study incorporates latecomer enterprises still establishing themselves in the industry into technology standards alliances. This empirical study provides support for two positive causal chains: the first being the relationship between "alliance routines (in three dimensions), exploration innovation, and group standardisation," and the second being the connection between "interactive consensus, exploration innovation, and group standardisation." The study's results demonstrate that enterprises, particularly latecomers, can join technological standards alliances. By engaging in alliance activities, these enterprises can steer their innovation endeavours and collaborate with other members to drive innovation. This collaborative

approach benefits the participating enterprises by driving their progress and enhancing the overall standardisation performance of the group, resulting in a mutually beneficial outcome. This study establishes a positive correlation between standards and innovation through a standardisation framework provided by technological standards alliances.

Third, in the context of technology standards alliances, the impact of alliance routines on ambidextrous innovation differs from that of other alliances or networks. The empirical findings of the present study demonstrate the divergent effects of technology standards alliance routines on two distinct types of innovation activities undertaken by its members. Specifically, alliance routines foster utilisation innovation amongst members while impeding exploration innovation. It is widely accepted within academic circles that alliance practices within technology alliances, R&D alliances, and cooperative networks promote both utilisation and exploration innovations (Jin, Shao & Wu, 2020; Lin, Qu & Hu, 2020; Mousavi, Bossink & Vliet, 2018). The contribution of this study lies in extending previous research, highlighting the necessity for researchers to consider the distinctive characteristics of technology standards alliances when investigating related topics. These characteristics encompass the eclectic nature of member interactions within technology standards alliances that deviate from single-mindedly seeking optimal solutions for industrial development. Moreover, due to the nature of the public goods standard, alliance members may refrain from sharing technical knowledge beyond the specified standard.

Practical implications

Based on these findings, we identify practical implications that can benefit latecomers' innovation performance through alliance routines. This study also highlights the significance of late-coming members of technical standards alliances. These implications focus on enhancing latecomers' ambidextrous innovation and leveraging latecomers to aid technical standards alliances in development.

Technical standards alliance implications

The effectiveness of a technology standards alliance depends on the efficiency of the standard formulation and the quality of the standards themselves.

Concerning the procedure for establishing standards, it is essential to understand that the development of standards is a collaborative process involving the consensus of all members of the alliance. During the inception phase of an alliance, managers play a critical role in shaping shared routines underpinned by a focus on technological innovation. A dedicated platform should be established to foster effective communication and knowledge exchange amongst alliance members. This approach encourages the sharing of expertise and enhances implicit cooperation within the alliance. Furthermore, striking a balance between implicit and explicit standards is crucial for maximising the governance capabilities of alliance routines.

Association standards are communal rather than proprietary assets and are subject to the “barrel effect,” whereby the overall standard is influenced by the technical capabilities of the least proficient members. Consequently, when managing alliance members, the progress of latecomer enterprises should be supported, and their technological advancements should be facilitated. The empirical analysis reveals that different aspects of alliance routines have varying impacts on the innovation strategies of latecomer enterprises. Thus, technology standards alliances should proactively adjust the emphasis placed on different dimensions of alliance practices, leveraging their positive influence on the innovation performance of latecomer enterprises while minimising the potential impediments they may encounter.

Implications for latecomers

- (1) Enhancing the synergy between standardisation and technological innovation is crucial in achieving comprehensive catch-up in technology and market occupation.

The practical and academic fields are more likely to equate the catch-up of latecomers with technological catching up, which is prone to a disconnect between technology and the market.

To address this phenomenon, latecomers may establish a “technology-standard-market” catch-up path, leveraging standards to bridge the gap between technology and market and enable coordinated catch-up in both areas. By synchronising technology development with standards, latecomers can leverage market-orientated standards to ensure technological innovations’ relevance and economic value. In addition, it is essential to swiftly transform technological innovations into standards, enabling market penetration through standardised implementation. This approach may help establish factual standards and allow latecomers to have a stronger influence on the market. Furthermore, by building on technology standards alliances, latecomers can establish patent pools and engage in cross-licencing amongst their members. This integration of standards and intellectual property rights further accelerates their catch-up process in a comprehensive “technology-patent-standard-market” chain system.

- (2) Latecomers should choose catch-up strategies based on different “moments” to form synergy between alliance routines and ambidextrous innovation.

Latecomers are advised to leverage the established behavioural logic inherent in alliance practices in utilisation innovation. By emulating industry leaders’ R&D and standardised processes, latecomers can enhance operational efficiency, minimise trial-and-error costs, and accelerate progress. Fostering robust interactions and communication amongst alliance members is essential. Strengthening relationships fosters mutual trust, cultivates shared understanding, and elevates overall cooperative performance. Conversely, latecomers are encouraged to chart an independent course when pursuing exploratory innovation, diverging from the conventional knowledge paradigms in the alliance network. Beyond the confines of homogenised knowledge, latecomers should actively seek diverse perspectives and embrace heterogeneous knowledge sources. Shedding ingrained behavioural and procedural patterns is crucial during this phase of innovation. By doing so, latecomers can establish their positions by creating collaborative and knowledge-centric network structures and carving out unique niches within the competitive landscape. Notably, the cultivation of implicit norms yields positive outcomes for both the utilisation and exploration of innovation catch-up strategies. Thus, latecomers are advised to proactively shape alliance

regulations while actively identifying and incorporating implicit knowledge resources within the alliance framework.”

Conclusions

This study investigates the impact of ambidextrous innovation catch-up within latecomer enterprises on technology standards alliances viewed through the lens of alliance routines. Using a sample comprising 45 technology standards alliances and 118 latecomer enterprises in China, this study employs an SEM to conduct an empirical analysis.

The study’s findings indicate that latecomers’ exploration and utilisation innovations positively influence the efficacy of technology standards alliances. First, this result underscores the positive implications of technological advancements on association standardisation, affirming the merit of the trajectory of “technology standardisation-standard marketisation.” Second, it substantiates the relevance and value of our investigation, emphasising the pivotal role latecomer enterprises play in technology standards alliances.

Simultaneously, the behavioural logic, implicit norms, and interactive consensus observed in alliance routines significantly enhance technology standards alliances. This result can be attributed to the coordination and control mechanisms encompassed within the code of conduct, effectively reducing cooperation costs between alliance members and augmenting the efficiency of standardisation activities. Implicit norms serve as repositories of tacit knowledge within the alliance and are the wellspring for technological research, development, and standardisation endeavours. Interactive consensus emerged as a collective understanding of tacit agreements and shared perspectives amongst alliance members. Fostering such a consensus helps bridge the divergences inherent in the standard-setting process and facilitates unified decisions.

The three dimensions of alliance routines have varying influences on the innovative catch-up activities of latecomer enterprises. All three dimensions significantly positively impact innovation utilisation within such enterprises. Behavioural logic and interactive consensus have a negative effect on exploratory innovation, while implicit norms play a positive role. This discrepancy can be attributed to exploratory innovation’s disruptive and transformative nature, paving the way for new technical trajectories. Behavioural logic and interactive consensus foster path dependency, constraining innovative thinking in latecomer enterprises. Conversely, implicit norms facilitate exploratory innovation by nurturing an environment conducive to creativity and experimentation. Utilisation innovation involves enhancing existing technologies with an emphasis on usability and practicality. In addition, behavioural logic and interactive consensus play a crucial role in aiding latecomers in assimilating into collaborative teams, acquiring new knowledge from alliances, and cultivating innovative ideas.

Limitations and future research

First, this research may have some limitations regarding industry coverage due to the difficulty in distributing and recovering questionnaires and the diversity of industries in the technical standards union. Follow-up research could further expand the capacity and scope of the sample.

Second, standardisation is a social coordination mechanism. Other subjects’ behaviours affect enterprises’ standardisation activities to some extent. Hence, a detailed study of different types of alliance enterprises may be conducted, comparing specific groups of enterprises (e.g., start-ups) in the context of the current wave of innovation and entrepreneurship to further enrich and expand the results of this study.

CRediT authorship contribution statement

Jing Hu: Conceptualization, Project administration, Writing – original draft, Writing – review & editing. **Siyu Chen:** Data curation, Investigation, Writing – original draft. **Xiaoqian Chen:** Methodology, Writing – original draft, Writing – review & editing. **Roman ZVAR-YCH:** Investigation, Software, Writing – review & editing.

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References

- Adamides, E., & Karacapilidis, N. (2020). Information technology for supporting the development and maintenance of open innovation capabilities. *Journal of Innovation & Knowledge*, 5(1), 29–38. doi:10.1016/j.jik.2018.07.001.
- Acker, A. (2014). The Short Message Service: Standards, infrastructure and innovation. *Telematics and Informatics*, 31(4), 559–568. doi:10.1016/j.tele.2014.01.004.
- Angwin, D. N., Paroutis, S., & Connell, R. (2015). Why good things don't happen: the micro-foundations of routines in the M&A process. *Journal of Business Research*, 68(6), 1367–1381. doi:10.1016/j.jbusres.2014.12.007.
- Berente, N., Lyytinen, K., Yoo, Y., & King, J. L. (2016). Routines as shock absorbers during organizational transformation: Integration, control, and NASA's enterprise information system. *Organization Science*, 27(3), 551–572. doi:10.1287/orsc.2016.1046.2016.
- Chang, S. J., Chung, C. N., & Mahmood, I. P. (2006). When and how does business group affiliation promote firm innovation? A tale of two emerging economies. *Organization Science*, 17(5), 637–656. doi:10.1287/orsc.1060.0202.
- Cheng, L., Dang, X. H., & Yang, Y. (2018). A study on the relationship between network practices and knowledge sharing curves: The moderating role of perceptual inertia and reflective reconfiguration. *Science and Technology Progress and Countermeasures*, 35(2), 140–146. doi:10.6049/kibydc.2017030658.
- Chiesa, V., Coughlan, P., & Voss, C. A. (1996). Development of a technical innovation audit. *Journal of Product Innovation Management*, 13(2), 105–136. doi:10.1111/1540-5885.1320105.
- Cohendet, P., & Simon, L. O. (2016). Always playable: recombining routines for creative efficiency at Ubisoft Montreal's video game studio. *Organization Science*, 27(3), 614–632. doi:10.1287/orsc.2016.1062.
- Egyedi, T. M., & Sherif, M. H. (2010). Standards dynamics through an innovation lens: next-generation ethernet networks. *IEEE Communications Magazine*, 48(10), 166–171. doi:10.1109/MCOM.2010.5594692.
- Farjoun, M. (2010). Beyond dualism: Stability and change as a duality. *The Academy of Management Review*, 35(2), 202–225. doi:10.5465/amr.2010.48463331.
- Feldman, M. S., & Pentland, B. T. (2003). Rethinking organizational routines as a source of flexibility and change. *Administrative Science Quarterly*, 48(1), 94–118. doi:10.2307/3556620.
- García-Canal, E., Valdés-Llaneza, A., & Sánchez-Lorda, P. (2014). Contractual form in repeated alliances with the same partner: The role of inter-organizational routines. *Scandinavian Journal of Management*, 30(1), 51–64. doi:10.1016/j.scaman.2013.06.001.
- Grégoire-Zawilski, M., & Popp, D. (2023). Do technology standards induce innovation in environmental technologies when coordination is important? *Research Policy*, 53(1), 104888. doi:10.1016/j.respol.2023.104888.
- Hemphill, T. A. (2005). *Cooperative strategy and technology standards setting: a study of U.S. wireless telecommunications industry standards development*. Washington, D. C.: The George Washington University.
- Hu, J., Wang, Y., Liu, S., & Song, M. (2022). Mechanism of latecomer enterprises' technological catch-up in technical standards alliances-An ambidextrous innovation perspective. *Journal of Business Research*, 154(2023). doi:10.1016/j.jbusres.2022.113321.
- Hoang, H., & Rothaermel, F. T. (2005). The effect of general and partner-specific alliance experience on joint R&D project performance. *Academy of Management Journal*, 48(2), 332–345. doi:10.5465/amj.2005.16928417.
- Jiang, H., Liu, & T. W. (2019). An overview of technical standard alliance characteristics and alliance development influencing factors. *Science and Technology Management Research*, 39(11), 153–158. doi:10.3969/j.issn.1000-7695.2019.11.021.
- Jiang, H., Wang, Z. S., Gao, S. P., Chen, K. H., & Sheng, F. (2023). Enhancing technology innovation performance through alliance capability: The role of standard alliance network and political skill of TMTs. *Frontiers In Psychology*, 13, 1008857. doi:10.3389/fpsyg.2022.1008857.
- Jiang, S. S., Gong, L. M., & Wei, J. (2011). Capacity catch-up of latecomer enterprises under the background of transition economy: A Co-evolutionary model – taking Geely Group as an example. *Management World*, (4), 130–145. doi:10.19744/j.cnki.11-1235/f.2011.04.013.
- Jin, Y., Shao, Y. F., & Wu, Y. B. (2020). Routine replication and breakthrough innovation: The moderating role of knowledge power. *Technology Analysis & Strategic Management*, 33(4), 426–438. doi:10.1080/09537325.2020.1818716.
- Lee, K., & Malerba, F. (2017). Catch-up cycles and changes in industrial leadership: Windows of opportunity and responses of firms and countries in the evolution of sectoral systems. *Research Policy*, 46(2), 338–351. doi:10.1016/j.respol.2016.09.006.
- Li, N., Liu, D., & Boadu, F. (2023). The impact of digital supply chain capabilities on enterprise sustainable competitive performance: An ambidextrous view. *Industrial Management & Data Systems*, 123(6), 1670–1689. doi:10.1108/IMDS-11-2022-0699.
- Li, W. (2014). The nature of technical standard alliance: based on the discernment of R&D alliance and patent alliance. *Research Management*, 35(10), 49–56. doi:10.19571/j.cnki.1000-2995.2014.10.007.
- Li, Y., Wang, R., Wang, T. X., & Wang, J. H. (2022). Exploring the relationship between network routines and innovation ecosystem performance in China: The moderating effect of transaction dependence. *Technological Forecasting and Social Change*, 178, 121565. doi:10.1016/j.techfore.2022.121565.
- Lin, H. F., Qu, T. C., & Hu, Y. F. (2020). How do organizational routines paradoxically affect organizational innovation? *European Journal of Innovation Management*, 24(4), 1400–1429. doi:10.1108/EJIM-03-2020-0093.
- Lin, H. F., & Shang, R. (2017). Definition of organizational routine and its construct dimensions: a grounded theory research. *Management Science*, 30(6), 113–129. doi:10.3969/j.issn.1672-0334.2017.06.009.
- Liu, Y., Wei, J., & Jiang, S. S. (2013). How do the latecomer firms catch up in innovation? A study from the perspective of the boundary expanding in R&D. *Management World*, 188(3), 96–110. doi:10.19744/j.cnki.11-1235/f.2013.03.009.
- Mousavi, S., Bossini, B., & Vliet, M. (2018). Dynamic capabilities and organizational routines for managing innovation towards sustainability. *Journal of Cleaner Production*, 203, 224–239. doi:10.1016/j.jclepro.2018.08.215.
- Peng, X. M., Zheng, S. L., & Wu, X. B. (2017). How do latecomers go from catching up to the frontier? – A perspective of dualistic learning. *Management World*, (2), 142–158. doi:10.19744/j.cnki.11-1235/f.2017.02.013.
- Pentland, B. T., Feldman, M. S., Becker, M. C., & Liu, P. (2012). Dynamics of organizational routines: A generative model. *Journal of Management Studies*, 49(8), 1484–1805. doi:10.1111/j.1467-6486.2012.01064.x.
- Pentland, B. T., Haerem, T., & Hillison, D. (2011). The (n)ever-changing world: Stability and change in organizational routines. *Organization Science*, 22(6), 1369–1383. doi:10.1287/orsc.1110.0624.
- Rerup, C., & Feldman, M. S. (2011). Routines as a source of change in organizational schema: The role of trial-and-error learning. *Academy of Management Journal*, 54(3), 577–610. doi:10.5465/amj.2011.61968107.
- Rui, Z. Y., & Luo, J. L. (2019). Double embeddedness in industrial networks and innovation catch-up of start-ups. *Research in Science*, 37(2), 267–275. doi:10.16192/j.cnki.1003-2053.2019.02.013.
- Shen, X. L. (2011). Research on the influencing factors of knowledge transfer in innovation networks—an analysis based on an empirical sample of small and medium sized enterprises. *Research in Science*, 29(3), 432–441. doi:10.16192/j.cnki.1003-2053.2011.03.017.
- Srisathan, W. A., Ketkaew, C., & Naruetharadhol, P. (2023). Assessing the effectiveness of open innovation implementation strategies in the promotion of ambidextrous innovation in Thai small and medium-sized enterprises. *Journal of Innovation & Knowledge*, 8(4), 100418. doi:10.1016/j.jik.2023.100418.
- Su, X. M., Hu, J., & Wang, Y. L. (2022). Cooperative network embedding, knowledge network structure and technological catch-up of latecomers: a technical standards alliance perspective. *Journal of Advanced Computational Intelligence and Intelligent Informatics*, 26(4), 619–630. doi:10.20965/jaciii.2022.p0619.
- Wang, P., Kwak, J., & Lee, H. (2014). The latecomer strategy for global ICT standardization: Indigenous innovation and its dilemma. *Telecommunications Policy*, 38(10), 933–943. doi:10.1016/j.telpol.2014.09.001.
- Wang, S. M., Wang, R. T., & Shao, Y. F. (2019). Research on the influence Mechanism of alliance convention on firms' dual innovation capability. *Management Science*, 32(02), 19–32. doi:10.3969/j.issn.1672-0334.2019.02.002.2019.
- Wen, J., Qualls, W. J., & Zeng, D. (2020). Standardization alliance networks, standard-setting influence, and new product outcomes. *Journal of Product Innovation Management*, 37(2), 138–157. doi:10.1111/jpim.12520.
- Wen, J. Y., Qualls, W. J., & Zeng, D. M. (2020). Standardization alliance networks, standard-setting influence, and new product outcomes. *Journal of Product Innovation Management*, 37(2), 138–157. doi:10.1111/jpim.12520.
- Wen, W., Forman, C., & Jarvenpaa, S. L. (2023). The effects of technology standards on complementor innovations: Evidence from the IETF. *Research Policy*, 51(6), 104518. doi:10.1016/j.respol.2022.104518.
- Xiao, Y., & Dang, X. H. (2018). Research on the Mechanism of network practice governance based on cross-level perspective. *Management Review*, 30(8), 90–101. doi:10.14120/j.cnki.cn11-5057/f.2018.08.008.2018.
- Xu, L., Yang, L. L., Li, D., & Shao, S. (2023). Asymmetric effects of heterogeneous environmental standards on green technology innovation: Evidence from China. *Energy Economics*, 117, 106479. doi:10.1016/j.eneco.2022.106479.
- Xu, N. N., Zhang, Y. H., & Zheng, F. (2020). A study on resources, innovation decision orientation and the evolution of innovation catch-up path of latecomer firms. *Science and Technology Progress and Countermeasures*, 37(18), 80–89. doi:10.6049/kibydc.2019040671.
- Yu, K., Qian, C., & Chen, J. L. (2022). How does intelligent manufacturing reconcile the conflict between process standards and technological innovation? *Journal of Engineering and Technology Management*, 65, 101698. doi:10.1016/j.jengtecman.2022.101698.
- Yu, X., Dai, Y. F., Xu, Q., & Ye, Q. L. (2023). Knowledge collaboration and benefits of standard implementation of enterprise in technology standard

- alliance. *Journal of The Knowledge Economy*, 14(4). doi:[10.1007/s13132-023-01340-7](https://doi.org/10.1007/s13132-023-01340-7).
- Zhang, T. (2009). Research on the relationship between innovation capability and competitive advantage based on absorptive capacity. *Research on Science*, 27(3), 445–452. doi:[10.16192/j.cnki.1003-2053.2009.03.014](https://doi.org/10.16192/j.cnki.1003-2053.2009.03.014).
- Zhang, X. Y., Quah, C. H., & Nor, M. N. B. (2023). Deep neural network-based analysis of the impact of ambidextrous innovation and social networks on firm performance. *Scientific Reports*, 13(1), 10301. doi:[10.1038/s41598-023-36920-9](https://doi.org/10.1038/s41598-023-36920-9).
- Zhang, Y., & Zhang, L. (2007). The governance mode of the technology standard alliance in the high-tech industry. *Science Research Management*, 28(6), 93–97. doi:[10.19571/j.cnki.10-295.207.06.012](https://doi.org/10.19571/j.cnki.10-295.207.06.012) 129.
- Zhou, Z. G., Wen, X. X., & Yang, F. (2023). Impact of network embeddedness on innovation performance: the perspective of organisational routine updating. *European Journal of Innovation Management*, 26(7), 378–400. doi:[10.1108/EJIM-05-2023-0437](https://doi.org/10.1108/EJIM-05-2023-0437).
- Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, 46(9), 339–351. doi:[10.1287/orsc.13.3.339.2780](https://doi.org/10.1287/orsc.13.3.339.2780).