



# How Digital Transformation Promotes Disruptive Innovation? Evidence from Chinese Entrepreneurial Firms

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## Abstract

How to enhance disruptive innovation to build sustainable competitive advantage has become an essential issue in strategic management research. However, few studies exist to elucidate the influencing mechanism of disruptive innovation in the context of the digital era. Using multivariate regression analysis and bootstrapping method, we examine the underlying mediating mechanism and contextual condition in the relationship between digital transformation and disruptive innovation. Our results demonstrate that the digital transformation of entrepreneurial firms has a significant positive effect on disruptive innovation. Interorganizational collaboration mediates the relationship between digital transformation and disruptive innovation. Moreover, we demonstrate that dynamic capabilities positively moderate the indirect effect of digital transformation on disruptive innovation through interorganizational collaboration. Our findings contribute to disruptive innovation research by explaining the mediating mechanism of how to utilize digital transformation to promote disruptive innovation vis interorganizational collaboration. Our results also explain how dynamic capabilities interact with interorganizational collaboration and significantly affect disruptive innovation.

**Keywords** Digital transformation · Interorganizational collaboration · Disruptive innovation · Dynamic capabilities · Entrepreneurial firms

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## Introduction

Originated from the seminal work by Abernathy and Clark (1985), disruptive innovation has become one of the most influential concepts in strategic management and innovation research, leading to profound findings from academic research and business practice (e.g., Christensen & Bower, 1996; Christensen et al., 2018; O'Reilly & Binns, 2019). The growing importance of disruptive innovation as a crucial way to build sustainable competitive advantage has attracted scholars to elucidate the influencing factors and how to promote disruptive innovation. Enormous literature has explored the conditions under which disruptive innovation is likely to take place within an organization, including organizational learning (e.g., Sherif et al., 2006), network externality (e.g., Parry & Kawakami, 2017), and organizational culture (e.g., Karimi & Walter, 2016). Despite the fruitful progress, most of these researches are limited to the context of the non-digital era. The new context, the digital era, brings about more opportunities and challenges (Nambisan et al., 2019), creating diverse avenues to advance disruptive innovation. Under this novel situation, the impact of organizational transformation enabling disruptive innovation deserves fine-grained examination. Remarkably, our understanding of whether and how digital transformation promotes disruptive innovation still needs improvement and is worthy of special attention in the digital era.

The motivation of this research effort is based on the observation that few studies have paid attention to the influencing mechanism of digital transformation on disruptive innovation, leading to a perplexing dilemma for entrepreneurial firms on how to enhance disruptive innovation in the digital context. In light of theoretical advancement, this paper aims to provide insights into the underlying mechanism of digital transformation affecting disruptive innovation. In this paper, we applied a normative quantitative approach, the Johnson-Neyman technique (Preacher et al., 2007), to test moderated mediation hypotheses and answer two main research questions:

- Whether digital transformation can enhance disruptive innovation?
- What is the underlying mechanism of digital transformation influencing disruptive innovation?

We choose to verify our hypotheses under the context of emerging economies. The reason is that emerging economies are becoming an essential source of disruptive innovation (Li, 2013). However, most research on disruptive innovations has focused on developed economies, and few studies explain this widely attractive phenomenon in emerging economies (Williamson et al., 2020). As the most prominent emerging economy, China provides a conducive environment for disruptive innovation (Wan et al., 2015). The reason is that China has formed an environment in which new customers with changeable needs, a booming growth of entrepreneurial firms, a flexible institutional context, and emerging digital technologies is continuously fusing. China's context transitional and fast-changing

characteristic leads to numerous opportunities for entrepreneurial firms to conduct disruptive innovations and compete with their counterparts (Zhang & Zhu, 2021). Consequently, we sent out 200 questionnaires to firms in representative regions of China in 2018, spent almost eight months on our survey study, and obtained primary data to conduct normative statistical analysis. Exploring the influencing mechanism of disruptive innovation in China will extend the previous research and provide new implications for firms' disruptive innovation in this particular environment.

## Research Background

*Digital transformation* refers to a fundamental change process that is enabled by the innovative use of digital technologies and accompanied by the strategic leverage of critical resources and capabilities, aiming to radically improve an organization, a business network, an industry, or society and redefine its value proposition for its stakeholders (Gong & Ribiere, 2021). It requires not just technology but also strategy alignment and other factors, such as people, culture, mindset, talent development, and leadership (Goran et al., 2017). Currently, digital technologies (e.g., cloud computing, social media, and data analytics) are changing the nature of business and enabling organizational transformation (Nambisan, 2017). Compared with traditional organizational governance, digital transformation reveals the characteristics of openness, affordances, and generativity (Nambisan et al., 2019). It is leveraged within organizational boundaries to orchestrate resource distribution, change the economic structure, and reshape the traditional interaction between consumers and businesses (Matarazzo et al., 2021). The application of digital technologies has the potential to revolutionize industrial logic by stimulating disruptive innovation (Palmié et al., 2020).

*Disruptive innovation* is a powerful means for broadening and developing new markets and providing new functionality, disrupting existing market linkages (Govindarajan & Kopalle, 2006). Eventually, it attracts mainstream consumers from existing markets and changes the technological paradigm (Christensen, 1997). In the digital era, digital technologies improve communication with existing and potential customers enabling a better understanding of requirements and facilitating customized offerings and new products tailored to specific customer needs (Matarazzo et al., 2021). Entrepreneurial firms are keen on adopting paths that the mainstream market actors (including incumbents and customers) ignore to facilitate disruptive innovation (Yu et al., 2022). By cultivating the niche market neglected by incumbents, entrepreneurial firms can sense and seize potential business opportunities relying on digital technologies. Accordingly, digital transformation utilizing digital technologies in the organizational process may play a crucial role in disruptive innovation. However, the underlying influencing mechanism and contextual conditions are still unclear. Therefore, it is an urgent research topic to elucidate how entrepreneurial firms' digital transformation facilitates disruptive innovation.

Due to the liability of smallness (Strotmann, 2007), entrepreneurial firms rely on interorganizational collaboration to overcome resource constraints (Chen et al., 2016).

*Interorganizational collaboration* is conceptualized as a characteristic of the innovation process related to the extent to which other organizations (firms or institutions) take an essential part in the innovation process (Alexiev et al., 2016). Therefore, interorganizational collaboration will positively facilitate innovation. However, at least two key issues need fine-grained research at present. First, although scholars have reached a unanimous conclusion about the positive effect of interorganizational collaboration on innovation (Zahoor & Al-Tabbaa, 2020), there still needs more theoretical analysis of the relationship between interorganizational collaboration and disruptive innovation. As a particular innovative activity, disruptive innovation may lead to fundamental change, meaning that interorganizational collaboration will play a more crucial role in disruptive innovation. Second, the digital economy promotes the efficiency of organizational management and strengthens collaboration between different organizations. Therefore, interorganizational collaboration may significantly improve information sharing and resource acquisition among stakeholders with digital transformation. However, only some studies explore the influencing mechanism of interorganizational collaboration on disruptive innovation, calling for empirical examination.

Disruptive innovation generates strategic change and renewal, while dynamic capabilities are crucial for firms to achieve this process (Helfat & Peteraf, 2015). *Dynamic capabilities* refer to the firm's ability to integrate, coordinate, and reconfigure internal and external competencies to cope with changing environments (Teece et al., 1997). They offer a route to competitive advantage under conditions of change (Ferreira et al., 2021; Schilke et al., 2018) and are consistent with the context of disruptive innovation. Dynamic capabilities also contribute to sense and seize opportunities (Teece, 2007), laying the foundation for implementing disruptive innovation. Therefore, dynamic capabilities may significantly affect the relationship between digital transformation and disruptive innovation. The effect of entrepreneurial firms' digital transformation and interorganizational collaboration on disruptive innovation may show differences under different levels of dynamic capabilities. However, extant literature research should pay more attention to dynamic capabilities' critical influencing mechanism, leading to a valuable theoretical gap.

Based on the digital technology perspective and dynamic capability theory, this study will analyze entrepreneurial firms' digital transformation's effect on disruptive innovation using data from China. Through theoretical analysis and empirical verification, we will fine-grained explore the mediating effect of interorganizational collaboration and the moderating effect of dynamic capabilities. We structure the paper as follows. After the introduction, we elucidate the theoretical underpinnings and hypothesis development, following the research method, analyses, and results. Finally, we discuss the theoretical contribution, managerial implications, and research limitations.

## Literature Review

### The Research of Digital Transformation

Information and communication technologies promote the advent of the digital and network society. Digital infrastructure (e.g., cloud computing, data analytics,

social media) accelerates the communication between firms and customers, brings about timely feedback from the market, and advances value appropriation (Rayna & Striukova, 2021), enabling a better understanding of requirements and facilitating customized offerings and new products tailored to specific customer needs (Verhoef et al., 2021). With the extensive application of digital technologies and infrastructure, firms have willingly transformed their operational logic and mode and sought digital transformation. Digital transformation introduces new business models by implementing novel business logic to create and capture value (Naimi-Sadigh et al., 2022). Therefore, it has become an approach to acquiring superior value and competitive advantage.

Transformation emphasizes that an organization's digital transformation goes far beyond functional thinking and considers the comprehensiveness of actions (Singh & Hess, 2017). The organization should exploit the opportunities and avoid threats from digital technologies. Digital transformation is fundamentally about strategy rather than technology (Rogers, 2016), which calls for the firm or organization to adjust strategic logic and capitalize on a novel and unexpected business model to advance value creation and capture. Digital transformation also necessitates advancing the existing knowledge about organizational change (Hanelt et al., 2021). A firm considering strategic transformation should form a holistic view of this change by systematically orchestrating resources and capabilities. A steady and coincident organizational environment is the prerequisite for a firm to advance digital transformation. Therefore, in promoting digital transformation, the firm should also pay more attention to adjusting its organizational culture, atmosphere, and insights besides using digital technologies.

## The Research of Disruptive Innovation

In early academic research, scholars used case studies to reveal the occurrence and constraints of disruptive innovation. O'Connor and Rice (2001) argued that it required a systematic analysis of uncertainties in technology, market, organization, and resources to identify the source of disruptive innovation. By facilitating disruptive innovation, the firm can cope with uncertainties from the internal and external environment (Carayannis et al., 2022).

Disruptive changes may emerge in existing technology paradigms and competition patterns (Bower & Christensen, 1995). This process brings about a high degree of innovation in new technologies, products, processes, services, and business models (Wan et al., 2015). In disruptive innovation, firms face constraints and obstacles from organizational identity, resource capabilities, and external markets (Sandberg & Aarikka-Stenroos, 2014). Recently, Kumaraswamy et al. (2018) analyzed how to promote disruptive innovation research from evolutionary, relational, temporal, and framing perspectives. Christensen et al. (2018) also began to focus on the evolution of disruptive innovation, shifting from a static analysis of disruptive innovation phenomena to a dynamic exploration of the evolution path and mechanism. The research of disruptive innovation has advanced from phenomenon description to theory building.

In light of the importance of disruptive innovation, scholars have explored the antecedents of disruptive innovation from diverse aspects. For external factors, numerous studies have paid more attention to environmental and institutional factors. The reason is that the industrial environment influences the effectiveness of a firm's operation, and the institutional factors reveal whether or not the industry can obtain necessary political support from governments. The organizational activities of any firm cannot exist independently without the external environment (Hitt et al., 2004). In a mature market economy, the economic operation mode has formed, resulting in few opportunities for disruptive innovation. Nevertheless, emerging economies contain potential sources of change (Li, 2013). The rapid development of technology and inter-industry integration constantly update the business operation mode and stimulate disruptive innovation activities. Technological turbulence from the external environment may provide new development opportunities for firms, change managers' cognitive inertia, and improve employees' creativity, benefiting disruptive innovation (Wang et al., 2022). Environmental factors can generate critical contextual effects on disruptive innovation, deserving attention. Disruptive innovation also requires appropriate institutional mechanisms (Si et al., 2020). Yi et al. (2014) analyzed how the government shaped the trajectory of disruptive innovation by promulgating policies during the rise of China's electric bicycle industry, showing how direct investment affects the strategy of electric bicycle companies and how the industry and institutional environment co-evolve. Public protection policies, such as government regulation and tax incentives, are conducive to the R&D and innovation of disruptive technologies (Pinkse et al., 2014).

Relatively, the internal factors affecting disruptive innovation focus on organizational resources, capability, and network links. The essential resources and abilities positively accelerate organizational change and promote innovation. Disruptive innovation is a holistic change to the current operation paradigm, market structure, and business logic, which requires firms to reserve the necessary resources and capabilities. Firms allocate resources to identify new potential customers, construct relationships with these customers, and develop knowledge about them (Wan et al., 2015), which facilitates disruptive innovation in emerging segments. Undoubtedly, under the context of the digital economy, digital technologies have become essential resources for firms to strengthen their close connection with customers. Firms can promote disruptive change and innovation by relying on abundant technology and human resources. A firm with a strong capability of acquiring and integrating information may have a high potential to transform the exchange of expertise and knowledge, expediting innovation correspondingly (Zhang & Zhu, 2021). That can facilitate firms to expand their visions of resource acquisition, accept novel thoughts, and widen their knowledge bases, resulting in seizing new disruptive innovation opportunities. Disruptive innovation increases the risk of failure, uncertainty, and volatility that firms have to handle. Disruptive innovation also involves distinct stakeholders (Kumaraswamy et al., 2018), which requires the cooperation of core firms, consumers, suppliers, distributors, financial institutions, research institutes, and government departments. Therefore, building network links with other stakeholders is crucial for entrepreneurial firms to advance disruptive innovation. The positive interaction between firms

and universities improved the knowledge level of employees in the organization, enhanced the ability of opportunity recognition, and promoted disruptive innovation significantly (Sebastian et al., 2019). The knowledge acquisition among stakeholders also promoted knowledge exchange and sharing among organizations and positively impacted the ecosystem's performance (Chen et al., 2016).

In sum, most current research focuses on the external (e.g., environmental and institutional factors) and internal factors (e.g., resource, capability, and network) that affect disruptive innovation, which has uncovered the influencing mechanism of disruptive innovation. However, with the widespread use of digital technologies, firms have to adjust traditional business logic and transform operational modes to adapt to the new digital environment. Digital transformation has become an irresistible trend, calling for more attention. Therefore, this study will explore the relationship between digital transformation and disruptive innovation, which may advance the existing research.

## Theoretical Hypotheses

### The Effect of Digital Transformation on Disruptive Innovation

Digital technology provides the necessary technical support for firms' innovation activities. By utilizing digital technologies, such as social media (Zhang & Zhu, 2021), firms are more likely to recognize new opportunities and threats in external environments and quickly commit resources to find solutions for innovative activities (Nguyen et al., 2015). For entrepreneurial firms, the digital platform and infrastructure facilitate them to identify and obtain market information. Entrepreneurial firms can use editable and transferable data supplied by digital technologies (Yoo et al., 2010). Relying on these resources can strengthen communication with the market, obtain information from terminal consumers, and meet market demand. For disruptive innovation, entrepreneurial firms must identify and acquire market demand ignored by existing firms. Through digital transformation, entrepreneurial firms introduce consumers to design, production, distribution, and service. Under the context of the digital economy, the traditional cost-leadership strategy, which emphasizes reducing operational costs, is no longer adapted to the development of the new situation. The importance of data has begun to dominate the business logic pursued by entrepreneurial firms, which requires firms to promote digital transformation and establish a digital platform. Leveraging digital technologies and adopting digital transformation have become entrepreneurial firms' crucial approaches to attracting the market's attention and supplying superior services. With the widespread digital transformation, entrepreneurial firms obtain massive market data and promote the capability of coping with changing environments timely, which lays a solid foundation for facilitating disruptive innovation. Therefore, we argue that:

Hypothesis 1: Digital transformation positively affects disruptive innovation.

## The Effect of Interorganizational Collaboration on Disruptive Innovation

Disruptive change in the business model involves multiple stakeholders within the industry (Teece, 2007). Disruptive innovation will transform the internal management within an organization and affect the operation rules of the whole industry. The change in the industry's current technological paradigm and competition pattern may lead to stakeholders' maladaptation to disruptive innovation activities. To ensure the implementation of disruptive innovation within the organization, entrepreneurial firms need to seek the coordination and cooperation of stakeholders (Minhas & Sindakis, 2021). Interorganizational collaboration reduces the cost of implementing innovative activities (Powell et al., 1996), such as new product promotion and new business model change. It also promotes entrepreneurial firms to obtain accurate market information from multiple channels at a lower cost (Wang et al., 2016), provides necessary market feedback for entrepreneurial firms to implement disruptive innovation, and improves the effectiveness of innovation activities. Furthermore, interorganizational collaboration can eliminate the external organization's constraints in implementing disruptive innovation. Therefore, we suggest that:

Hypothesis 2: Interorganizational collaboration positively affects disruptive innovation.

## The Mediating Effect of Interorganizational Collaboration

With the popularization of digital technologies, numerous communication channels exist between entrepreneurial firms and stakeholders. Through digital architectures (e.g., APIs and cloud), entrepreneurial firms' digital management has continuously improved. Digital technologies also improve communication with existing and potential customers, enabling a better understanding of requirements and facilitating customized offerings and new products tailored to specific customer needs (Matarazzo et al., 2021). Moreover, digital transformation utilizes digital technologies to enable interactions across borders with suppliers, customers, and competitors (Singh & Hess, 2017). In terms of culture and organization, taking digital transformation as an entrepreneurial firm's organizational strategy is in line with the current trend of firm management. For entrepreneurial firms, it is easier to obtain recognition from partners, which enhances the trust between partners and promotes interorganizational collaboration. Implementing digital transformation in technology will significantly improve the connection between entrepreneurial firms and stakeholders. Mobile digital technologies facilitate transferring and sharing of information in a unified coding rule (Yoo et al., 2010). It will reduce the cost of information communication and improve the speed of information transmission. These new digital technologies may also affect firms' cost structure by reducing supply chain costs using blockchain (Verhoef et al., 2021). Therefore, entrepreneurial firms' digital transformation can significantly promote interorganizational collaboration.



Hypothesis 3: Digital transformation positively affects interorganizational collaboration.

The digital transformation of entrepreneurial firms can facilitate disruptive innovation. However, this process may depend on the promotion of interorganizational collaboration. This mediating effect reflects in two aspects. One is the reduction of the cost of information transfer. Through digital transformation, entrepreneurial firms update the technical means of organizational operation and enhance the links with external stakeholders to transfer information conveniently and efficiently (Nambisan, 2017). To ensure disruptive innovation activities, entrepreneurial firms must eliminate conflicts with external organizations. The other is the improvement of the accuracy of information acquisition. The basis and premise for entrepreneurial firms to carry out disruptive innovation is the accurate acquisition of market information (Roy & Cohen, 2017). By utilizing digital technologies, entrepreneurial firms can leverage the digital platform to obtain market feedback (Nambisan, 2017) and enhance the market recognition of disruptive innovation. However, due to the inherent constraint of limited operational experience, more than a single information channel is needed to guarantee the implementation of disruptive innovation in entrepreneurial firms (Roy & Cohen, 2017). They have to expand the channels of information sources. Using the digital platform, entrepreneurial firms can promote interorganizational collaboration, obtain more accurate market information from various stakeholders, and promote disruptive innovation consequently.

Hypothesis 4: Interorganizational collaboration mediates the relationship between digital transformation and disruptive innovation.

### The Moderating Effect of Dynamic Capabilities

Dynamic capabilities reflect firms' capabilities to integrate, coordinate, and reconfigure internal and external competencies to adapt to changing environments (Teece et al., 1997). They are usually used to explain how firms respond to rapid technological change (Eisenhardt & Martin, 2000). These capabilities promote the reconfiguration of resources to maintain evolutionary fitness (Teece, 2007). Firms with outstanding dynamic capabilities can sense opportunities and threats from the internal and external environment, effectively integrate and restructure assorted assets, obtain superior performance, and maintain a sustainable competitive advantage compared with competitors under fierce market competition (Eisenhardt & Martin, 2000). Dynamic capabilities are crucial for firms to achieve strategic change and renewal (Helfat & Peteraf, 2015).

As firms' ability to address rapidly changing situations, dynamic capabilities are used more in vibrant environments, such as those influenced by digital technologies. Consequently, they may also play an essential role in a firm's digital transformation (Matarazzo et al., 2021). Whether entrepreneurial firms have outstanding dynamic capabilities will significantly affect the implementation of disruptive innovation. As high-level organizational capabilities, dynamic capabilities contain generic sensing, seizing, and transforming capacities. Depending on dynamic capabilities,

entrepreneurial firms will perceive and acquire market opportunities and information (Colombo et al., 2021). The ability to perceive and obtain information improves in cooperation with external stakeholders. It also promotes the implementation of disruptive innovation activities. The high level of dynamic capabilities also improves entrepreneurial firms' ability to resource integration (Teece, 2007). Entrepreneurial firms can obtain the necessary resources by building collaboration with external organizations. The effective orchestration of external and internal resources has become an important method to prevent resource conflict that restricts disruptive innovation. Under outstanding resource orchestrating capability, entrepreneurial firms can integrate external resources into internal management more effectively and promote innovative activities (Schilke et al., 2018). Therefore, a high level of dynamic capabilities promotes disruptive innovation by improving the efficiency of information acquisition and resource integration. Thus, we suggest that:

**Hypothesis 5:** Dynamic capabilities positively moderate the indirect effect of digital transformation on entrepreneurial firms' disruptive innovation via interorganizational collaboration, such that the effect will be stronger when dynamic capabilities are greater.

## Research Design

### An Overview of the Methodology

This study used a back-translation strategy to develop the questionnaire and ensure conceptual accuracy (Zhang & Zhu, 2021). We designed the questionnaire utilizing firm interviews and a literature review. To ensure the questionnaire's validity and clarity in the Chinese context, we conducted a pre-survey on a small group of managers (i.e., senior managers and R&D managers) in 20 different firms after the preliminary completion of the questionnaire. First, we informed the manager of the academic purpose of this survey in advance. We promised that all the data they offered would be confidential and used only in academic studies. Second, we requested the managers to answer all the survey items and discussed the clarity and appropriateness of terminology. Finally, we carefully refined the questionnaire to ensure all the items were understandable and comprehensive according to their feedback. This process ensured that the interviewers could accurately understand the connotation of each item in the questionnaire.

During variable measurement, we measured core variables (disruptive innovation, dynamic capabilities, and interorganizational collaboration) using measurement scales obtained from other academic studies whose validities and reliabilities have been verified. However, notwithstanding the related research has achieved fruitful results, there is no unified measurement scale of digital transformation. Digital maturity is recognized as the standard for judging digital transformation results (Chen & Tian, 2022). Therefore, we followed Chen and Tian (2022)'s research and used the digital maturity assessment model of Gill and Vanboskirk (2016) to measure digital transformation in four dimensions: culture, organization, technology,

and insight. This scale evaluated the current situation of an organization's digital transformation better. In consequence, the measurement scales of this study reveal acceptable validities and reliabilities.

We used normative regression statistical analysis to test the hypotheses. For the main effects (Hypotheses 1–3), we regressed interorganizational collaboration and disruptive innovation on the independent and control variables. Because the mediating effect of interorganizational collaboration (Hypothesis) is the main component of our research, following the research of De Clercq et al. (2018), we tested this hypothesis through three complementary approaches:

- Baron and Kenny (1986)'s three-step procedure
- the Sobel test (Sobel, 1982)
- the bootstrapping method suggested by Preacher and Hayes (2004)

For the moderated mediation effects (Hypothesis), we followed Preacher et al. (2007)'s method to report a direct difference in the strength of the mediating effect at different levels of dynamic capabilities, which could provide generated confidence intervals for the moderated mediating effects (MacKinnon et al., 2004).

## Data Collection and Variable Measurement

In the formal research stage, we chose entrepreneurial firms from the service, electronic communication, equipment manufacturing, and other industries in China's Shaanxi, Shandong, and Jiangsu provinces in 2018. Due to China's uneven economic environment, the coastal and inland areas vary significantly in their economic development (Zhou et al., 2014). Therefore, we chose firms from coastal provinces (Shandong and Jiangsu) and inland provinces (Shaanxi) to consider such variations. These geographical locations represent China's economic, geographic, and demographic diversities.

We sent out 200 questionnaires to firms in the three provinces. Two researchers adopted a face-to-face interview with each firm's managers in the investigation. Although costly and time-consuming, this method can effectively ensure that the questions are answered thoroughly and seriously, which affects the quality of the questionnaire responses (Sheng et al., 2011). We requested two managers to finish different sections of the questionnaire to reduce the potential problem of common methods variance. We sent at least two interviewers to survey each firm. The interviewers went to the firm and conducted the surveys with two managers separately. The selection criterion for these two managers is that they should be the CEO or general managers in charge of sales, organization operation, or R&D. During the survey, the interviewers explained the interview process and the method of filling in the questionnaire thoroughly. They asked the questions using a uniform script to eliminate any biases. The interviewees filled in the questionnaires on the spot and supplemented them timely in case of any omission. In China, this procedure is crucial for ensuring quality control and reliability of the data (Atuahene-Gima, 2005).

Finally, we obtained 168 questionnaires and excluded 22 due to incomplete completion. Therefore, the usable questionnaire was 146. The participation rate of the questionnaire was 84%, and the effective rate was 73%. We used a *t* test to compare the responding and non-responding firms to test non-response bias. The analysis was insignificant for firm size and age, indicating a low possibility of non-response bias (Armstrong & Overton, 1977). Table 1 represents the profile of the sample.

In this study, we measured the variables using a five-point Likert scale that ranged from 1 (strongly disagree) to 5 (strongly agree). Table 2 presents the description of each item.

*Digital transformation.* Following the research of Chen and Tian (2022), we used the digital maturity assessment model of Gill and Vanboskirk (2016) to measure the independent variable in four dimensions: culture, organization, technology, and insight. Each dimension contains seven items; thus, we obtain 28 items shown in Table 2.

*Interorganizational collaboration.* Using Alexiev et al. (2016)'s measurement of interorganizational collaboration, we asked the respondents to assess the role of external parties at critical stages of the innovation value chain, such as product or service development, production, marketing, distribution, and supply directly. Six of the statements pertain to interorganizational collaboration (Cronbach alpha = 0.914): (1) our company works together with other organizations for product and/or service innovations; (2) our company works together

**Table 1** Distribution of sample firms

		Frequency	Percentage (%)
1. Industry	Manufacturing	29	19.9
	Construction	3	2.1
	Electronic information	23	15.7
	Catering	25	17.1
	Finance and insurance	2	1.4
	Real estate	5	3.4
	Service industry	59	40.4
2. Firm age	≤ 1	8	5.5
	2	39	26.7
	3	25	17.1
	4	39	26.7
	≥ 5	35	24.0
3. Number of employees	≤ 20	24	16.4
	21–50	44	30.2
	51–100	47	32.2
	> 100	31	21.2
4. Ownership	State-owned firm	29	19.9
	Foreign-invested firm and joint-venture	6	4.1
	Private firm	106	72.6
	Collectively owned firm	5	3.4

**Table 2** Measurement items and validity assessment

Construct	Dimension	Item	Loading	Validity
Competitive intensity		1. The industrial competition is fierce	0.749	C.R.: 0.856 AVE: 0.543 $\alpha$ : 0.787
		2. Customers often change their suppliers	0.721	
		3. Competitors often seize our customers	0.761	
		4. The industrial products are similar	0.747	
		5. Low-price is the best way of competition	0.706	
Environmental dynamism		1. It is difficult to predict actual users of our products	0.909	C.R.: 0.945 AVE: 0.774 $\alpha$ : 0.927
		2. It is difficult to predict competitors for our supply of raw materials and parts	0.871	
		3. It is difficult to predict competitors for our customers	0.894	
		4. It is difficult to predict government regulations controlling our industry	0.882	
		5. It is difficult to predict the public's political views and attitudes toward our industry	0.840	
Digital transformation	Culture	1. We believe that our competitive strategy depends on digital	0.852	C.R.: 0.946 AVE: 0.715 $\alpha$ : 0.931
		2. Our board and our C-level executives back our digital strategy	0.885	
		3. We have the right leaders to execute on our digital strategy day-to-day	0.850	
		4. We invest in targeted digital education and training at all levels of our organization	0.881	
		5. We clearly communicate our digital vision both internally and externally	0.850	
		6. We take measured risks in order to enable innovation	0.799	
		7. We prioritize overall customer experience over the performance of any individual channel	0.796	

Table 2 (continued)

Construct	Dimension	Item	Loading	Validity
Organization	Organization	1. Our organization structure prioritizes customer journeys over functional silos	0.848	C.R.: 0.946 AVE: 0.713 $\alpha$ : 0.932
		2. We dedicate appropriate resources to digital strategy, governance, and execution	0.854	
		3. The staff supporting our critical digital functions are best in class	0.867	
		4. We have digital skills embedded throughout our organization	0.854	
		5. Our organization model encourages cross-functional collaboration	0.879	
		6. We have defined and repeatable processes for managing digital programs	0.800	
		7. Our vendor partners deliver value that enhances our digital competencies	0.806	
Technology	Technology	1. Our technology budget is fluid to allow for shifting priorities	0.775	C.R.: 0.922 AVE: 0.630 $\alpha$ : 0.898
		2. Our marketing and technology resources work together to co-create our digital technology road map	0.818	
		3. We have a flexible, iterative, and collaborative approach to technology development	0.837	
		4. We leverage modern architectures (APIs, cloud, etc.) to promote speed and flexibility	0.835	
		5. We measure our technology teams by business outcomes not just system up-time	0.836	
		6. We use customer experience assets, like personas and journey maps, to steer our technology design	0.717	
		7. We use digital tools to promote employee innovation, collaboration, and mobility	0.727	
Insights	Insights	1. We have clear and quantifiable goals for measuring the success of our digital strategy	0.845	C.R.: 0.948 AVE: 0.722 $\alpha$ : 0.935
		2. Every employee understands how her performances ties to corporate digital goals	0.805	

Table 2 (continued)

Construct	Dimension	Item	Loading	Validity
Interorganizational collaboration		3. We use customer-centric metrics like Net Promoter Score or Lifetime value to measure success	0.848	
		4. We measure how channels work together to accomplish a desired outcome	0.876	
		5. Customer insight actively steers our digital strategy	0.893	
		6. Customer insights inform digital design and development	0.855	
		7. We feed lessons learned from digital programs back into our strategy	0.824	
		1. Our company works together with other organizations for product and/or service innovations	0.809	C.R.: 0.933 AVE: 0.699 $\alpha$ : 0.914
		2. Our company works together with other organizations in order to put new products and services to market	0.835	
Dynamic capabilities	Sensing capability	3. Our company allies with other organizations in order to introduce new products and/or services	0.829	
		4. Our company implements joint promotional activities for new products and/or services	0.871	
		5. Our company maintains joint distribution and service agreements for new products and services	0.838	
		6. Our company signs contracts with other companies and institutions for product development	0.833	
		1. Our company knows the best practices in the market	0.840	C.R.: 0.927 AVE: 0.718 $\alpha$ : 0.901
		2. Our company is up to date on the current market situation	0.871	
		3. Our company systematically searches for information on the current market situation	0.826	
		4. As a company, we know how to access new information	0.874	
		5. Our company always has an eye on our competitors' activities	0.824	

Table 2 (continued)

Construct	Dimension	Item	Loading	Validity	
Seizing capability	Transforming capability	1. Our company can quickly relate to new knowledge from the outside	0.837	C.R.: 0.905 AVE: 0.704 $\alpha$ : 0.860	
		2. We recognize what new information can be utilized in our company	0.828		
		3. Our company is capable of turning new technological knowledge into process and product innovation	0.839		
		4. Current information leads to the development of new products or services	0.852		
		1. By defining clear responsibilities, we successfully implement plans for changes in our company	0.847	C.R.: 0.925 AVE: 0.712 $\alpha$ : 0.898	
	Disruptive innovation	Transforming capability	2. Even when unforeseen interruptions occur, change projects are seen through consistently in our company	0.859	
			3. Decisions on planned changes are pursued consistently in our company	0.831	
			4. In the past, we have demonstrated our strengths in implementing changes	0.836	
			5. In our company, change projects can be put into practice alongside the daily business	0.845	
			1. Our company's new products are disruptive	0.901	C.R.: 0.956 AVE: 0.814 $\alpha$ : 0.942
Disruptive innovation	Transforming capability	2. Our company rarely introduces products that are disruptive in nature*	0.923		
		3. Our company lags behind in introducing disruptive product innovations*	0.918		
		4. The new products that are introduced by our company are very attractive to a different customer segment at the time of product introduction	0.907		
		5. The new products that are introduced by our company are those where the mainstream customers find the innovations attractive over time as they are able to satisfy the requirements of the mainstream market	0.859		
		Items with an asterisk are reverse-scaled and have been recoded accordingly			



with other organizations in order to put new products and services to market; (3) our company allies with other organizations in order to introduce new products and/or services; (4) our company implements joint promotional activities for new products and/or services; (5) our company maintains joint distribution and service agreements for new products and services; and (6) our company signs contracts with other companies and institutions for product development.

*Dynamic capabilities.* Following the research of Kump et al. (2019), we used three sub-dimensions to measure dynamic capabilities. We adopted five indicators to measure sensing capability and transforming capability separately and four items to measure seizing capability. In addition, we computed three dimensions' arithmetic mean to measure dynamic capabilities.

*Disruptive innovation.* We used a five-item scale to measure the dependent variable following Govindarajan and Kopalle (2006)'s research. Five items could present the disruptiveness of innovations (Cronbach alpha=0.956): (1) our company's new products are disruptive; (2) Our company rarely introduces products that are disruptive in nature; (3) our company lags behind in introducing disruptive product innovations; (4) the new products that are introduced by our company are very attractive to a different customer segment at the time of product introduction; and (5) the new products that are introduced by our company are those where the mainstream customers find the innovations attractive over time as they are able to satisfy the requirements of the mainstream market.

*Control variables.* This study controlled firm age, size, industry type, competitive intensity, and environmental dynamism. The longer firms are established, the stronger their innovation ability is (Arend, 2014). Firms' willingness to change will decrease due to inertia; consequently, it is necessary to control firm age. Firm age was measured by calculating the natural logarithm of the years since firms were founded. This method could avoid the error caused by the left or right deviation of the quantitative variable distribution. Case studies and surveys in high-tech industries have shown that firm size negatively correlates to disruptive innovation success (Dan & Chieh, 2010). Firm size is also an important indicator of competitiveness that affects resource commitment (Westhead et al., 2001). Therefore, firm size should be controlled in our analysis. We measured firm size using the common logarithm of employees' numbers. The firms involved in high-tech and non-high-tech industries reveal significant differences in innovative activities (Siegel & Hambrick, 2005). High-tech firms prefer to invest resources into organizational activities. In contrast, those in non-high-tech industries can equally acquire superior performance by improving efficiency, which may reduce their investment. We controlled industry type with a dummy variable (1 = high-tech industry, 0 = otherwise). Besides, competitive intensity and environmental dynamism can affect disruptive innovation (Christensen et al., 2018; Zhang & Zhu, 2021). These two variables were measured using five items separately. The measurement items can also be founded in Table 2.

## Reliability and Validity Test

We applied confirmatory factor analysis to validate the scales. As shown in Table 2, the reliability and validity of the scale were acceptable because both factor loadings and Cronbach alpha were all above 0.700. Furthermore, the confirmatory factor analysis of the multi-factor model showed that all indexes were within the acceptable range, indicating that the model fits well ( $\chi^2/df=2.018$ ,  $p=0.000$ ,  $RMSEA=0.084$ ,  $RMR=0.026$ ,  $CFI=0.805$ ,  $IFI=0.807$ ). Accordingly, the validity of all construct aggregations passed the test.

The convergence validity test was judged by the average variance extraction (AVE) value and the combination reliability. The AVE values of all variables in Table 2 were greater than 0.500, and the combined reliability values were greater than 0.700, indicating that each variable revealed convergence validity. The difference validity was judged by whether the square root of the AVE was greater than the correlation coefficient between variables. The minimum square root of AVE in Table 2 was 0.737, while the maximum correlation coefficient between the variables in Table 3 was 0.585. Accordingly, this comparison showed that each variable presented different validity.

The problem of common method variance (CMV) must be considered in statistical analysis (Podsakoff et al., 2003). Therefore, we adopted particular methods to reduce potential CMV. First, for ex-ante process control, we mixed and reshuffled the order of questions to reduce the possibility that the respondent may easily combine related items to cognitively “create” the correlation, making CMV less likely (Murray et al., 2005). We also designed the survey statements as clear, simple, and easy to comprehend as possible to reduce the potential misunderstanding among the respondents. Second, in the investigation process, we explicitly declared that the questionnaire was anonymous to reduce the possible fear from the respondents. Through this method, we can obtain the actual situation of firm management. Third, some post hoc statistical analyses are effective methods to reduce CMV. The results of Harman’s one-factor analysis showed that the principal component analysis could explain 74.317% of the variability, more than 60%, and the first principal component

**Table 3** Descriptive statistics and correlation matrix

	1	2	3	4	5	6	7	8	9
1. FA	1								
2. FS	0.527**	1							
3. IT	-0.059	0.051	1						
4. CI	-0.008	-0.050	0.035	1					
5. ED	-0.036	-0.061	-0.031	-0.121	1				
6. DT	-0.115	-0.081	0.119	0.222**	-0.086	1			
7. IC	-0.090	-0.003	0.177*	0.258**	-0.155	0.488**	1		
8. DC	-0.007	0.028	0.313**	0.218**	-0.035	0.432**	0.585**	1	
9. DI	-0.019	-0.019	0.165*	0.024	0.004	0.277**	0.396**	0.274**	1
Mean	1.129	1.710	0.521	3.562	3.862	3.869	3.763	3.735	3.712
S.D.	0.442	0.348	0.501	0.451	0.653	0.344	0.514	0.367	0.661

a. \* and \*\* denote significance at the 0.05 and 0.01 levels (2-tailed). b. FA firm age, FS firm size, IT industry type, CI competitive intensity, ED environmental dynamism, DT digital transformation, IC interorganizational collaboration, DC dynamic capabilities, DI disruptive innovation

accounted for 28.563% of the variability in these data, less than 50%, indicating that CMV would not produce a serious impact on the research results. Fourth, CMV is more likely to emerge in overly simple models (Chang et al., 2010). While in this research, we built a theoretical framework containing the moderated mediating effect, a relatively complex relationship that could reduce potential CMV. Consequently, the results of this research will not be affected by the problem of CMV.

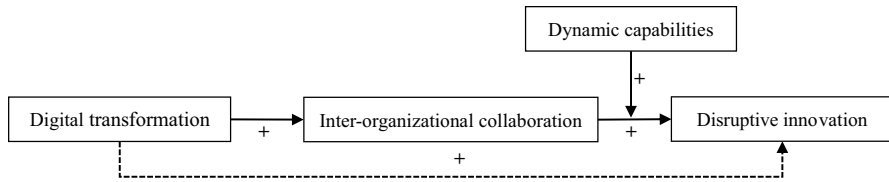
## Research Analysis

In Table 3, we provide the descriptions of the variables and their correlations. While Table 4 reports the regression results. Models 1–2 predict interorganizational collaboration, and models 3–6 predict disruptive innovation. In models 1 and 3, only the control variables are included. Models 2, 4 and 5 add the direct effects. For every model, the variance inflation factor values are less than the conservative cut-off value of 5.0 (Studenmund, 1992), so our research has no serious and harmful multicollinearity.

**Table 4** Regression analysis results ( $N=146$ )

Variables	IC		Disruptive innovation			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Firm age	-0.120 (-1.277)	-0.076 (-0.902)	0.008 (0.076)	0.033 (0.344)	0.058 (0.636)	0.007 (0.079)
Firm size	0.061 (0.649)	0.072 (0.846)	-0.030 (-0.303)	-0.022 (-0.226)	-0.045 (-0.492)	-0.006 (-0.070)
Industry type	0.148 (1.338)	0.104 (1.045)	0.332* (1.982)	0.274 (1.683)	0.195 (1.250)	-0.009 (-0.083)
Competitive intensity	0.243** (3.016)	0.151* (2.036)	0.018 (0.214)	-0.039 (-0.467)	-0.093 (-1.152)	-0.098 (-1.233)
Environmental dynamism	-0.124 (-1.537)	-0.096 (-1.321)	0.010 (0.118)	0.027 (0.331)	0.061 (0.781)	0.059 (0.764)
Digital transformation		0.437*** (5.891)		0.273** (3.257)	0.119 (1.334)	0.142 (1.577)
IC					0.359*** (3.942)	0.369*** (3.660)
DC						0.065 (0.655)
IC*DC						0.158* (2.492)
$R^2$	0.105	0.283	0.028	0.097	0.189	0.220
Adjusted $R^2$	0.074	0.252	-0.006	0.058	0.147	0.168
$F$ -value	3.322**	9.215***	0.816	2.494*	4.582***	4.282***

IC interorganizational collaboration, DC dynamic capabilities; unstandardized estimates;  $t$  values are in parentheses; \*, \*\*, and \*\*\* denote significance at the 0.05, 0.01, and 0.001 levels

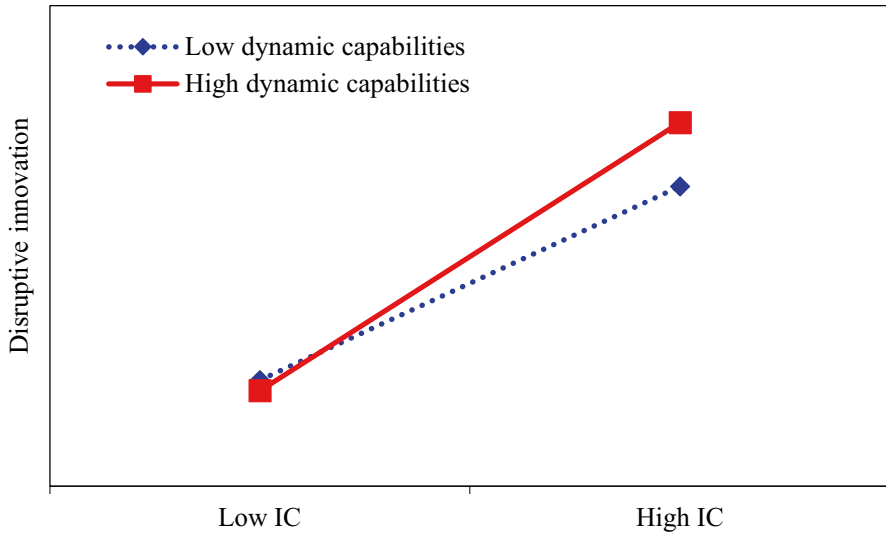


**Fig. 1** Theoretical framework

For Hypothesis, we argue that digital transformation positively affects disruptive innovation. The results of model 4 support this hypothesis ( $\beta=0.273$ ,  $p<0.01$ ). The positive relationship between interorganizational collaboration and disruptive innovation is also confirmed in model 5 ( $\beta=0.359$ ,  $p<0.001$ ), supporting hypothesis 2. Furthermore, hypothesis 3 can also be verified through model 2 ( $\beta=0.437$ ,  $p<0.001$ ).

The mediating effect of interorganizational collaboration is tested by Baron and Kenny (1986)'s approach. First, the direct relationship between digital transformation and interorganizational collaboration has been confirmed ( $\beta=0.437$ ,  $p<0.001$ ; model 2). Second, the direct relationship between digital transformation and disruptive innovation is significantly positive, ignoring the effect of interorganizational collaboration ( $\beta=0.273$ ,  $p<0.01$ ; model 4). Third, adding the effect of interorganizational collaboration, the significance of the direct effect of digital transformation on disruptive innovation becomes insignificant ( $\beta=0.119$ , n.s., model 5). In this study, we adopt two additional methods to verify the mediating effect of interorganizational collaboration. First, according to the relationships between the independent variable and the mediator (model 2) and between the mediator and the dependent variable (model 5), the Sobel test indicates that the indirect effect of digital transformation on disruptive innovation through interorganizational collaboration is significant ( $z=3.682$ ,  $p<0.001$ ). Second, the bootstrapping approach suggested by Preacher and Hayes (2004) reveals that the indirect effect of dynamic capabilities is significant ( $p<0.01$ ) using 1000 random samples and replacement from the full sample (Shrout & Bolger, 2002). The bias-corrected confidence interval (CI) for this indirect effect does not include zero ([0.195, 0.582]), supporting the mediating effect (Fig. 1).

We also find support for hypothesis 5: the mediating effect of interorganizational collaboration on the relationship between digital transformation and disruptive innovation is moderated by dynamic capabilities ( $\beta=0.158$ ,  $p<0.05$ ; model 6). We illustrate this moderating effect in Fig. 2, which reveals steeper positive curves at high levels of dynamic capabilities. Further, we adopt the method of Preacher et al. (2007) to test the moderated mediation effect. We compute bias-corrected CIs (confidence intervals) at three selected levels of dynamic capabilities, using the same specification of 5000 random samples and replacement from the full sample (Shrout & Bolger, 2002). From Table 5, we can find that although the bootstrap 95% CI of the conditional effect at one standard deviation below the mean of dynamic capabilities contains 0 [−0.035, 0.188], showing that under this context, the indirect effect of digital transformation on disruptive innovation is insignificant ( $\beta=0.075$ , n.s.), the replication of this procedure at the mean and one standard deviation above



**Fig. 2** The moderating effect of dynamic capabilities on the relationship of interorganizational collaboration (IC) and disruptive innovation

the mean of dynamic capabilities generates two CIs that do not include 0 ([0.042, 0.271] and [0.086, 0.391]), indicating that the conditional indirect effects of digital transformation on disruptive innovation are significant ( $\beta=0.161$ ,  $p<0.01$  and  $\beta=0.247$ ,  $p<0.01$ ). Besides, the value of the indirect effect of digital transformation on disruptive innovation increases with the increment of the moderator. Table 5 also reveals that the difference in indirect effect between high and low moderators is significant ( $\beta=0.172$ ,  $p<0.05$ ).

Moreover, to further verify whether the indirect effect is affected by dynamic capabilities, we tested whether the Boot CI of the index of the moderated mediation contained zero. The results shown in Table 6 indicated that the moderated mediation effect was positive and presented a non-zero probability ( $\beta=0.086$ ; 95% bias-corrected CI: [0.010, 0.151]). Therefore, dynamic capabilities positively moderate the indirect relationship between digital transformation and

**Table 5** Results of bootstrapping method for moderated mediation

Condition	Indirect effect	Boot SE	t	95% confidence interval	
				Lower limit	Upper limit
Low (−1 SD)	0.075	0.056	1.335	−0.035	0.188
Middle (0)	0.161	0.057	2.840	0.042	0.271
High (+1 SD)	0.247	0.076	3.237	0.086	0.391
High-Low	0.172	0.072	2.396	0.019	0.301

Note: Bootstrap samples = 5000; conditions for moderator are the mean and plus/minus one standard deviation from the mean. SE standard error. Estimates were calculated using the PROCESS macro

**Table 6** Results of moderated mediation analysis

Independent variable	Dependent variable	Mediator	Moderator	Index	Boot SE	Boot 95% CI	
						LL	UL
Digital transformation	Disruptive innovation	Interorganizational collaboration	Dynamic capabilities	0.086	0.036	0.010	0.151

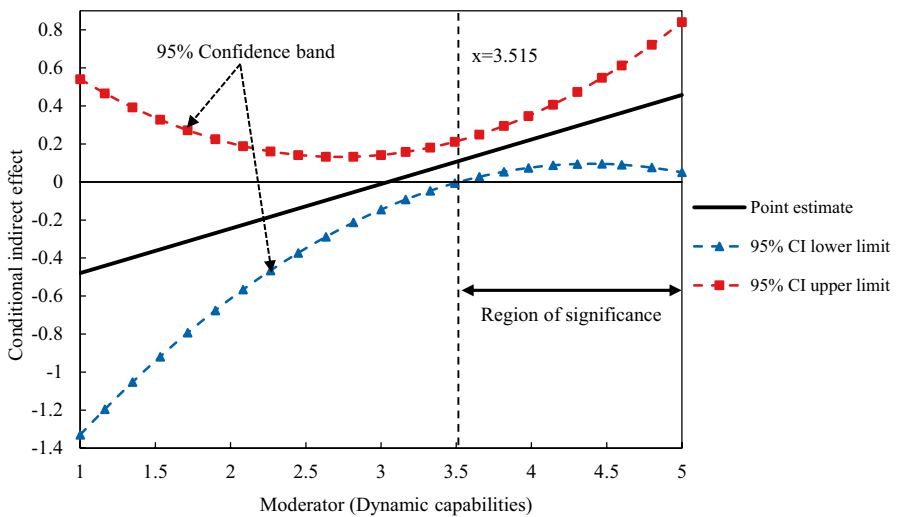
Bootstrap samples = 5000. *SE* standard error, *CI* confidence interval, *LL* lower limit, *UL* upper limit

**Table 7** A summary of the hypotheses

Hypothesis	The content	Statistical result
1	Digital transformation positively affects disruptive innovation	Supported
2	Interorganizational collaboration positively affects disruptive innovation	Supported
3	Digital transformation positively affects interorganizational collaboration	Supported
4	Interorganizational collaboration mediates the relationship between digital transformation and disruptive innovation	Supported
5	Dynamic capabilities positively moderate the indirect effect of digital transformation on entrepreneurial firms' disruptive innovation via interorganizational collaboration, such that the effect will be stronger when dynamic capabilities are greater	Conditionally supported

disruptive innovation through interorganizational collaboration. Thus, hypothesis 5 is also supported (Table 7).

Using the Johnson-Neyman technique (Preacher et al., 2007), we plotted the conditional indirect effect of digital transformation on disruptive innovation via interorganizational collaboration with an accompanying 95% confidence, based on the second-order variance, as shown in Fig. 3. The findings indicated that the indirect effects were significantly from zero when dynamic capabilities were above the critical value ( $x = 3.515$ ). When dynamic capabilities are high, the indirect effect would be significant. While the moderator was low, the indirect effect was insignificant. These results proclaim the moderating effect of dynamic capabilities on the mediating relationship of digital transformation with disruptive innovation via interorganizational collaboration. Therefore, hypothesis 5 was verified again.



**Fig. 3** The conditional indirect effect of digital transformation on disruptive innovation via interorganizational collaboration versus the moderator, with 95% confidence bands

## Discussion and Conclusions

Promoting disruptive innovation has become a crucial choice for entrepreneurial firms to cope with changing environment and build sustained competitive advantage, which has attracted widespread concern in strategy management literature research. With the development of the digital economy, more firms have begun to explore digital transformation. However, previous studies should have paid more attention to the effect of digital transformation on disruptive innovation. Based on the digital technology perspective and dynamic capability theory, this study elucidated the underlying influencing mechanism of entrepreneurial firms' digital transformation on disruptive innovation. Using data from China, we proposed the potential moderated mediation relationship among digital transformation, interorganizational collaboration, dynamic capabilities, and disruptive innovation. The first four hypotheses were verified, and the fifth one was conditionally supported; the moderated mediating effect would be significant only when dynamic capabilities were high. These results answered this study's core research question of whether and how digital transformation enhanced disruptive innovation.

## Research Conclusions

Our result of hypothesis 1 indicates that entrepreneurial firms leverage editable and transferable digital technologies to strengthen communication with the market and obtain information from consumers. Market information is the crucial basis for firms to carry out disruptive innovation. Entrepreneurial firms utilize digital platforms to access market information and strengthen close ties with customers, promoting disruptive innovation. Consequently, entrepreneurial firms' digital transformation significantly influences their disruptive innovation.

Interorganizational collaboration is essential in mediating the relationship between entrepreneurial firms' digital transformation and disruptive innovation. For entrepreneurial firms, digital transformation presents a positive signal to gain the recognition of stakeholders and promote interorganizational collaboration. The cost of obtaining information for entrepreneurial firms will decrease with the improvement of interorganizational collaboration. It will be easier for entrepreneurial firms to obtain the necessary and accurate information from the external environment. Therefore, interorganizational collaboration mediates the relationship between entrepreneurial firms' digital transformation and disruptive innovation.

Dynamic capabilities are important factors affecting organizational change and renewal. Entrepreneurial firms can seize opportunities and reconfigure assets effectively with outstanding dynamic capabilities. In the context of the digital economy, entrepreneurial firms can obtain more market information from external stakeholders. At the same time, tremendous asset-transforming capacity promotes entrepreneurial firms to combine and reconfigure firms' intangible and tangible assets, promoting disruptive innovation effectively. Therefore, dynamic capabilities



conditionally moderate entrepreneurial firms' digital transformation's effect on disruptive innovation via interorganizational collaboration.

## Theoretical Contributions

The theoretical contribution of this study is reflected in three aspects. First, this research explains the influence mechanism of disruptive innovation in the context of the digital economy. Previous work on disruptive innovation research focused on the organizational changes caused by the green revolution (Hopp et al., 2018) and showed how it transformed the traditional manufacturing industry (Carayannis et al., 2022; Ruan et al., 2014). Nowadays, the widespread utilization of digital technologies has rendered organizational outcomes and processes less bounded (Nambisan, 2017), supplying more opportunities to promote disruptive change. Digitization is not merely a context for innovation; digital technologies have become active in orchestrating organizational resources and fueling innovative initiatives (Nambisan et al., 2019). However, scholarship on digital management and disruptive innovation has yet to build a close link between them, leading to no unambiguous answer about whether and how a firm's digital transformation enabled by the application of digital technologies will advance its disruptive change and innovation. Therefore, this study focuses on the crucial role of digital transformation in positively promoting disruptive innovation and points out that the firm needs to transform to place digital at the heart of its business strategy. By relying on digital technology, firms can accelerate information acquisition, improve asset reconfiguration, and carry out disruptive innovation. Consequently, this study reveals an essential channel for firms to implement disruptive innovation in the digital economy.

Second, the impact mechanism of digital transformation on disruptive innovation is clarified by combining the digital technology perspective and dynamic capability theory. Our results reveal that interorganizational collaboration mediates between digital transformation and disruptive innovation. Digital technologies enable a better understanding of customer needs (Matarazzo et al., 2021), improve stakeholder communication, and strengthen interorganizational collaboration. The intermediary mechanism will be achieved by reducing the transaction costs between firms and external stakeholders, which is necessary for firms to carry out disruptive innovation in the digital economy. The collaboration between organizations results in sharing of critical resources and facilitates knowledge transfer (Hardy et al., 2003; Powell et al., 1996). To improve the effectiveness of resource integration, a firm needs to build dynamic capabilities to advance resource allocation, reallocation, combination, and recombination (Teece, 2007). Disruptive innovation research may benefit from the classic dynamic capabilities perspective (Hopp et al., 2018). However, only some studies have focused on their relationship, leaving a theoretical gap for our research. This study elucidated the dynamic capabilities' role in the underlying influencing mechanism of digital transformation affecting disruptive innovation via interorganizational collaboration, introducing the dynamic capabilities perspective into disruptive innovation research, and developing the theoretical core of disruption research.

The third is the combination of digital management and disruptive innovation in the context of entrepreneurship. In the digital economy, malleable, editable, and transferable digital technologies are reconstructing the industry environment and bringing about the non-linear development of innovation (Yoo et al., 2010). Digital technologies and transformation have also transformed the nature of uncertainty inherent in entrepreneurial processes and outcomes as well as the ways of coping with such uncertainty (Nambisan, 2017). Interpreting the role of digital-technology-related theoretical constructs within the research domains in entrepreneurship will produce significant theoretical contributions (Sahut et al., 2021). Disruptive innovation theory has become one of the most important theories in entrepreneurship (Si et al., 2020). Disruptive innovations are often the source of new waves of entrepreneurship. Therefore, disruptive innovation and entrepreneurship have a close relationship, leading to fruitful research findings (Christensen et al., 2018). However, for disruptive innovation research, most findings come from developed economies, traditionally the source of these innovations (Si et al., 2020). Our study combines digital management and disruptive innovation in the context of entrepreneurship, verifies the hypotheses using data from an emerging economy, and extends the current academic research.

### Managerial Implications

This research also brings about important managerial implications. First, digital transformation is essential for firms to strengthen core competitiveness. Digital technology has changed the organizational structure and business model, challenging the basic assumptions of innovation theory. New business models emerge continuously, and the forms of industrial organization are constantly reshaping. Furthermore, the value of the digital economy is embodied in improving transaction efficiency and promoting digital transformation. The wide application of digital technology generates disruptive innovation of traditional technological paradigms and business operation modes. In the context of the digital economy, disruptive innovation will affect all aspects of product development, technological innovation, and business model innovation. It also provides opportunities for entrepreneurial firms' disruptive innovation. Therefore, firms need to strengthen digital transformation to promote their competitiveness.

Second, interorganizational collaboration significantly promotes innovation. Entrepreneurial firms maintain organizational flexibility and strategic adjustment, but they need more heterogeneous resources and R&D capabilities to make them choose to anchor specific niches in the industry ecosystem. Relying on digital technology, the collaboration with stakeholders from the innovation ecosystem provides critical customer information and R&D resources for entrepreneurial firms. The unique heterogeneous resources owned by a firm determine its core competitiveness. However, the ecosystem changes the logic of resource management, which significantly increases the resources utilized by firms. Consequently, entrepreneurial firms should strengthen interorganizational collaboration to overcome their liability of smallness.

Third, the construction of dynamic capabilities guarantees to implementation of organizational activities. Dynamic capabilities facilitate entrepreneurial firms to implement business model innovation. Entrepreneurial firms often need more resources and focus on improving asset reconfiguration. Through cultivating dynamic capabilities, entrepreneurial firms can strengthen the acquisition of external opportunities and improve the ability of resource utilization, enhancing the efficiency of organizational innovation correspondingly.

## Research Limitations

This study has several limitations. First, digital transformation and disruptive innovation are in dynamic evolution. With the change in the internal and external environment, their relationship may change accordingly. This paper only analyzes their relationship using cross-sectional data and fails to verify their dynamic influence mechanism. Future research can rigorously demonstrate the impact mechanism of digital transformation on disruptive innovation by introducing longitudinal data. Second, this paper focuses on the mediating mechanism of interorganizational collaboration between digital transformation and disruptive innovation, revealing the impact of digital management on disruptive innovation from the digital technology perspective. Future research can further examine the impact of digital transformation on disruptive innovation from multiple perspectives.

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**Data Availability** The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Declarations

**Competing Interests** The authors declare no competing interests.

## References

- Abernathy, W., & Clark, K. B. (1985). Innovation: Mapping the winds of creative destruction. *Research Policy*, *14*(1), 3–22.
- Alexiev, A. S., Volberda, H. W., & Van den Bosch, F. A. (2016). Interorganizational collaboration and firm innovativeness: Unpacking the role of the organizational environment. *Journal of Business Research*, *69*(2), 974–984.
- Arend, R., & J. (2014). Entrepreneurship and dynamic capabilities: How firm age and size affect the ‘capability enhancement-SME performance’ relationship. *Small Business Economics*, *42*(1), 33–57.
- Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, *14*(7), 396–402.

- Atuahene-Gima, K. (2005). Resolving the capability-rigidity paradox in new product innovation. *Journal of Marketing*, 69(4), 61–83.
- Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6), 1173–1182.
- Bower, J. L., & Christensen, C. M. (1995). Disruptive technologies: Catching the wave. *Harvard Business Review*, 73, 43–53.
- Carayannis, E. G., Christodoulou, K., Christodoulou, P., Chatzichristofis, S. A., & Zinonos, Z. (2022). Known unknowns in an era of technological and viral disruptions-implications for theory, policy, and practice. *Journal of the Knowledge Economy*, 13, 587–610.
- Chang, S. J., van Witteloostuijn, A., & Eden, L. (2010). From the editors: Common method variance in international business research. *Journal of International Business Studies*, 41(2), 178–184.
- Chen, H. S., & Tian, Z. (2022). Environmental uncertainty, resource orchestration and digital transformation: A fuzzy-set QCA approach. *Journal of Business Research*, 139, 184–193.
- Chen, P. L., Tan, D., & Jean, R. J. (2016). Foreign knowledge acquisition through inter-firm collaboration and recruitment: Implications for domestic growth of emerging market firms. *International Business Review*, 25(1), 221–232.
- Christensen, C. M. (1997). *The innovator's dilemma*. Harvard Business School Press.
- Christensen, C. M., & Bower, J. (1996). Customer power, strategic investment, and the failure of leading firms. *Strategic Management Journal*, 17(3), 197–218.
- Christensen, C. M., McDonald, R., Altman, E. J., & Palmer, J. E. (2018). Disruptive innovation: An intellectual history and directions for future research. *Journal of Management Studies*, 55(7), 1043–1078.
- Colombo, M. G., Piva, E., Quas, A., & Rossi-Lamastra, C. (2021). Dynamic capabilities and high-tech entrepreneurial ventures' performance in the aftermath of an environmental jolt. *Long Range Planning*, 54(3), 102026.
- Dan, Y., & Chieh, H. C. (2010). A reflective review of disruptive innovation theory. *International Journal of Management Reviews*, 12(4), 435–452.
- De Clercq, D., Thongpapanl, N., & Voronov, M. (2018). Sustainability in the face of institutional adversity: Market turbulence, network embeddedness, and innovative orientation. *Journal of Business Ethics*, 148(2), 1–19.
- Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, 21(10–11), 1105–1121.
- Ferreira, J., Cardim, S., & Coelho, A. (2021). Dynamic capabilities and mediating effects of innovation on the competitive advantage and firm's performance: The moderating role of organizational learning capability. *Journal of the Knowledge Economy*, 12, 620–644.
- Gill, M., & Vanboskirk, B. S. (2016). The digital maturity model 4.0 benchmarks: Digital business transformation playbook[R]. <https://www.forrester.com/report/the-digital-maturity-model-40>
- Gong, C., & Ribiere, V. (2021). Developing a unified definition of digital transformation. *Technovation*, 102, 102217.
- Goran, J., LaBerge, L., & Srinivasan, R. (2017). Culture for a digital age. *McKinsey Quarterly*, 3(1), 56–67.
- Govindarajan, V., & Kopalle, P. K. (2006). Disruptiveness of innovations: Measurement and an assessment of reliability and validity. *Strategic Management Journal*, 27(2), 189–199.
- Hanelt, A., Bohnsack, R., Marz, D., & Antunes Marante, C. (2021). A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change. *Journal of Management Studies*, 58(5), 1159–1197.
- Hardy, C., Phillips, N., & Lawrence, T. B. (2003). Resources, knowledge and influence: The organizational effects of interorganizational collaboration. *Journal of Management Studies*, 40(2), 321–347.
- Helfat, C. E., & Peteraf, M. A. (2015). Managerial cognitive capabilities and the microfoundations of dynamic capabilities. *Strategic Management Journal*, 36(6), 831–850.
- Hitt, M. A., Ahlstrom, D., Dacin, M. T., Levitas, E., & Svobodina, L. (2004). The institutional effects on strategic alliance partner selection in transition economies: China vs. Russia. *Organization Science*, 15(2), 173–185.
- Hopp, C., Antons, D., Kaminski, J., & Oliver Salge, T. (2018). Disruptive innovation: Conceptual foundations, empirical evidence, and research opportunities in the digital age. *Journal of Product Innovation Management*, 35(3), 446–457.

- Karimi, J., & Walter, Z. (2016). Corporate entrepreneurship, disruptive business model innovation adoption, and its performance: The case of the newspaper industry. *Long Range Planning*, 49(3), 342–360.
- Kumaraswamy, A., Garud, R., & Ansari, S. S. (2018). Perspectives on disruptive innovations. *Journal of Management Studies*, 55(7), 1025–1042.
- Kump, B., Engelmann, A., Kessler, A., & Schweiger, C. (2019). Toward a dynamic capabilities scale: Measuring organizational sensing, seizing, and transforming capacities. *Industrial and Corporate Change*, 28(5), 1149–1172.
- Li, P. P. (2013). Introduction: disruptive innovation from the bottom of the pyramid. In: Li, P. P. (Ed.), *Disruptive innovation in Chinese and Indian businesses: The strategic implications for local entrepreneurs and global incumbents*. Routledge, London.
- MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research*, 39(1), 99–128.
- Matarazzo, M., Penco, L., Profumo, G., & Quaglia, R. (2021). Digital transformation and customer value creation in made in Italy SMEs: A dynamic capabilities perspective. *Journal of Business Research*, 123, 642–656.
- Minhas, J., & Sindakis, S. (2021). Implications of social cohesion in entrepreneurial collaboration: A conceptual model and research propositions. *Journal of the Knowledge Economy*, 12, 2016–2031.
- Murray, J. Y., Kotabe, M., & Zhou, J. N. (2005). Strategic alliance-based sourcing and market performance: Evidence from foreign firms operating in China. *Journal of International Business Studies*, 36(2), 187–208.
- Naimi-Sadigh, A., Asgari, T., & Rabiei, M. (2022). Digital transformation in the value chain disruption of banking services. *Journal of the Knowledge Economy*, 13, 1212–1242.
- Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. *Entrepreneurship Theory and Practice*, 41(6), 1029–1055.
- Nambisan, S., Wright, M., & Feldman, M. (2019). The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. *Research Policy*, 48(8), 103773.
- Nguyen, B., Yu, X., Melewar, T. C., & Chen, J. (2015). Brand innovation and social media: Knowledge acquisition from social media, market orientation, and the moderating role of social media strategic capability. *Industrial Marketing Management*, 51, 11–25.
- O'Connor, G., & Rice, M. P. (2001). Opportunity recognition and breakthrough innovation in large established firms. *California Management Review*, 43(2), 95–116.
- O'Reilly, C., & Binns, A. J. M. (2019). The three stages of disruptive innovation: Idea generation, incubation, and scaling. *California Management Review*, 61(3), 49–71.
- Palmié, M., Wincent, J., Parida, V., & Caglar, U. (2020). The evolution of the financial technology ecosystem: An introduction and agenda for future research on disruptive innovations in ecosystems. *Technological Forecasting and Social Change*, 151, 119779.
- Parry, M. E., & Kawakami, T. (2017). The encroachment speed of potentially disruptive innovations with indirect network externalities: The case of E-readers. *Journal of Product Innovation Management*, 34(2), 141–158.
- Pinkse, J., Bohnsack, R., & Kolk, A. (2014). The role of public and private protection in disruptive innovation: The automotive industry and the emergence of low-emission vehicles. *Journal of Product Innovation Management*, 31(1), 43–60.
- Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5), 879–903.
- Powell, W. W., Koput, K. W., & Smith-Doerr, K. L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly*, 41(1), 116–145.
- Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, 36(4), 717–731.
- Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research*, 42(1), 185–227.
- Rayna, T., & Striukova, L. (2021). Involving consumers: The role of digital technologies in promoting 'prosumption' and user innovation. *Journal of the Knowledge Economy*, 12, 218–237.
- Rogers, D. (2016). *The digital transformation playbook: Rethink your business for the digital age*. Columbia University Press.

- Roy, R., & Cohen, S. K. (2017). Stock of downstream complementary assets as a catalyst for product innovation during technological change in the U.S. machine tool industry. *Strategic Management Journal*, 38(6), 1253–1267.
- Ruan, Y., Hang, C. C., & Wang, Y. M. (2014). Government's role in disruptive innovation and industry emergence: The case of the electric bike in China. *Technovation*, 34(12), 785–796.
- Sahut, J. M., Iandoli, L., & Teulon, F. (2021). The age of digital entrepreneurship. *Small Business Economics*, 56, 1159–1169.
- Sandberg, B., & Aarikka-Stenroos, L. (2014). What makes it so difficult? A systematic review on barriers to radical innovation. *Industrial Marketing Management*, 43(8), 1293–1305.
- Schilke, O., Hu, S. C., & Helfat, C. E. (2018). Quo vadis, dynamic capabilities? A content-analytic review of the current state of knowledge and recommendations for future research. *Academy of Management Annals*, 12(1), 390–439.
- Sebastian, K., Jutta, S. W., & Welpel, I. M. (2019). More is not always better: Effects of collaboration breadth and depth on radical and incremental innovation performance at the project level. *Research Policy*, 48(1), 1–10.
- Sheng, S., Zhou, K. Z., & Li, J. J. (2011). The effects of business and political ties on firm performance: Evidence from China. *Journal of Marketing*, 75(1), 1–15.
- Sherif, K., Zmud, R. W., & Browne, G. J. (2006). Managing peer-to-peer conflicts in disruptive information technology innovations: The case of software reuse. *MIS Quarterly*, 30(2), 339–356.
- Shrout, P. E., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: New procedures and recommendations. *Psychological Methods*, 7(4), 422–455.
- Si, S., Zahra, S. A., Wu, X., & Jeng, D. J. F. (2020). Disruptive innovation and entrepreneurship in emerging economies. *Journal of Engineering and Technology Management*, 58, 101601.
- Siegel, P. A., & Hambrick, D. C. (2005). Pay disparities within top management groups: Evidence of harmful effects on performance of high-technology firms. *Organization Science*, 16(3), 259–274.
- Singh, A., & Hess, T. (2017). How chief digital officers promote the digital transformation of their companies. *MIS Quarterly Executive*, 16(1), 1–17.
- Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. *Sociological Methodology*, 13, 290–312.
- Strotmann, H. (2007). Entrepreneurial survival. *Small Business Economics*, 28, 87–104.
- Studenmund, A. H. (1992). *Using econometrics: A practical guide*. Harper Collins.
- Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28(13), 1319–1350.
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533.
- Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, 122, 889–901.
- Wan, F., Williamson, P. J., & Yin, E. (2015). Antecedents and implications of disruptive innovation: Evidence from China. *Technovation*, 39, 94–104.
- Wang, C. X., Qureshi, I., Guo, F., & Zhang, Q. P. (2022). Corporate social responsibility and disruptive innovation: The moderating effects of environmental turbulence. *Journal of Business Research*, 139, 1435–1450.
- Wang, Y., Wang, N., Jiang, L., Yang, Z., & Cui, V. (2016). Managing relationships with power advantage buyers: The role of supplier initiated bonding tactics in long-term buyer-supplier collaborations. *Journal of Business Research*, 69(12), 5587–5596.
- Westhead, P., Wright, M., & Ucbasaran, D. (2001). The internationalization of new and small firms: A resource-based view. *Journal of Business Venturing*, 16(4), 333–358.
- Williamson, P. J., Feng, W., Yin, E., & Lei, L. (2020). Is disruptive innovation in emerging economies different? Evidence from China. *Journal of Engineering and Technology Management*, 57, 101590.
- Yi, R., Chang, C. H., & Yan, M. W. (2014). Government's role in disruptive innovation and industry emergence: The case of the electric bike in China. *Technovation*, 34(12), 785–796.
- Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010). The new organizing logic of digital innovation: An agenda for information systems research. *Information Systems Research*, 21(4), 724–735.
- Yu, W. Z., Dai, S. P., Liu, F., & Yang, Y. (2022). Matching disruptive innovation paths with entrepreneurial networks: A new perspective on startups' growth with Chinese evidence. *Asian Business & Management*, EarlyCite., <https://doi.org/10.1057/s41291-022-00177-3>

- Zahoor, N., & Al-Tabbaa, O. (2020). Inter-organizational collaboration and SMEs' innovation: A systematic review and future research directions. *Scandinavian Journal of Management*, *36*(2), 101109.
- Zhang, F., & Zhu, L. (2021). Social media strategic capability, organizational unlearning, and disruptive innovation of SMEs: The moderating roles of TMT heterogeneity and environmental dynamism. *Journal of Business Research*, *133*(7), 183–193.
- Zhou, K. Z., Li, J. J., Sheng, S., & Shao, A. T. (2014). The evolving role of managerial ties and firm capabilities in an emerging economy: Evidence from China. *Journal of the Academy of Marketing Science*, *42*(6), 581–595.

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