

Research and prospects of platform empowerment theory from the perspective of digital business ecosystems

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Abstract. Platforms facilitate the linkage, sharing, and innovation of various subjects in the digital business ecosystem through enabling activities. However, a comprehensive theoretical framework for platform enablement research has not yet been established. This study utilizes CiteSpace software to visualize and analyze the literature on platform empowerment in CNKI and Web of Science. In constructing an integrated theoretical framework of value nodes, value chains, and value networks, the entry perspective is the digital business ecosystem. In the digital business ecosystem, platform empowerment activities create value for enterprises, individual users, government, and other subjects. Value creation in the value chain depends on the resource flow and activity linkage of the data chain, commodity chain, and innovation chain. The operation of the value network can promote the formation of the "virtual industrial agglomeration" to some extent. This study aims to develop an integrated framework for platform empowerment theory. It proposes potential research directions for platform heterogeneity, cross-boundary value co-creation, and virtual industrial agglomeration in the future.

Keywords: platform enterprises, empowerment, digital business ecosystems, platform governance

1. Introduction

Platforms serve as important carriers of digital information technologies and services, continuously enabling improvements in enterprise performance and capability development through enhanced resource matching and deployment. With the deepening development of Web 3.0, emerging technologies such as cloud computing, big data, and artificial intelligence are increasingly integrated with economic development, making "platform empowerment" a crucial approach for enterprises to actively participate in the digital economy [1]. Digital business ecosystems centered around platforms are gradually taking shape.

The continuous emergence of new technologies and new contexts in the digital economy era provides fertile ground for the differentiated positioning of platforms. As Internet technologies gradually penetrate from consumer-oriented platforms to industry-oriented platforms [2], the platforms themselves are also continuously breaking through their traditional operational logic and business models. In new contexts characterized by a significant increase in participating actors and increasingly complex interaction mechanisms, the high-quality development of platform-empowered enterprises within digital business ecosystems faces new opportunities and challenges. This, in turn, places new requirements on the theory of platform empowerment, which originally emerged from the consumer Internet domain.

From a practical perspective, a well-established theoretical framework can provide logically coherent guidance for enterprise management and operational practices. From a theoretical perspective, a comprehensive understanding and in-depth exploration of platform empowerment theory is also essential for interpreting theoretical regularities regarding value creation and strategic transformation in the digital economy era. The positive role of platform empowerment has been widely recognized by scholars; however, current literature reviews on platform empowerment mostly focus on specific types of platforms [3] or the application of cutting-edge Internet technologies [4]. There remains a lack of an integrated framework that consolidates both domestic and international research on platform empowerment, limiting its applicability in practice.

In view of this, the present study employs bibliometric methods and tools to summarize research trends on platform empowerment domestically and internationally. It further synthesizes the characteristics of existing studies from four perspectives: research subjects, mechanism pathways, theoretical perspectives, and research methods. Ultimately, the study adopts the theory of digital business ecosystems as the foundational framework. Referring to the structural classification of digital business ecosystem operations, the study integrates domestic and international research into a three-level theoretical

framework of "value nodes—value chains—value networks". Based on the systematic review of this framework, the study proposes future research directions for platform empowerment, focusing on key issues. By organizing the theory at the ecosystem level, this study provides conceptual guidance for the further development of platform empowerment theory and offers practical guidance for the orderly and healthy development of platform empowerment activities within digital business ecosystems.

2. Visualized analysis of platform empowerment literature

2.1. Literature search and publication trends

In the literature search stage, this study selected the CNKI database and the Web of Science Core Collection to retrieve relevant publications. For domestic research literature, the CNKI database was used, with the cutoff date set to June 14, 2024. The CSSCI journal project was chosen, and the keyword platform empowerment was searched in titles, abstracts, and keywords. After manually removing irrelevant publications and cross-checking the references of key papers to identify missing literature, a total of 1,021 Chinese-language publications were obtained. For international literature, the Web of Science Core Collection was used, with the search terms "platform empowerment", "empowerment of platform", and "digital economy". The search fields included titles, abstracts, author keywords, and Keywords Plus, and the document types were limited to ARTICLE and REVIEW. The cutoff date was the same as that for the Chinese literature. The screening and adjustment procedures were conducted in the same manner, yielding 1,034 international publications relevant to the topic.

Regarding publication trends, the number of studies on platform empowerment has shown a clear upward trajectory. The publication dates of Chinese literature are concentrated from 2015 to the present, whereas discussions in English-language literature span from 2006 to the present. In international studies, research on "empowerment" can be traced back to discussions on "authorization". In the context of international research, there is a strong transitional relationship between the concepts of "authorization" and "empowerment". By contrast, domestic research on the theory of "platform empowerment" has generally developed more recently, largely driven by management practices arising from the rapid development of the digital economy.

2.2. Visualized analysis of domestic research literature

In the keyword co-occurrence analysis of Chinese literature, terms such as digital economy, digital governance, technological empowerment, and digital technology accounted for a large proportion within the research domain of platform empowerment. Based on keyword co-occurrence, further clustering revealed 13 major research categories.

Benefiting from the maturity of Internet technologies, digital industries and digital society have emerged as new research hotspots. Domestic research on platform empowerment has extended from 2015 to the present, and studies related to the topic of "platform empowerment" exhibit the following four main characteristics: First, the primary research subjects are platform enterprises and their stakeholders. Platform enterprises are characterized by diversity, encompassing entrepreneurial platforms, consumer platforms, and industrial platforms, which can be generally classified into consumer Internet platforms and industrial Internet platforms. Second, regarding the mechanism pathways of platform empowerment, organizational value co-creation activities are emphasized as an important performance outcome of empowerment. In-depth case studies of practical management scenarios have become a key method for refining empowerment pathways. Third, domestic research perspectives are relatively broad. From authorization empowerment in human resource management to ecological empowerment in innovation ecosystems, studies focusing on platform management practices have become important focal points across various disciplines and research fields. Fourth, in terms of research methods, case studies are among the more commonly employed approaches. The theory of "platform empowerment" is currently in an exploratory stage, with mature conceptual definitions and scale constructions still requiring further research and refinement.

2.3. Visualized analysis of international research literature

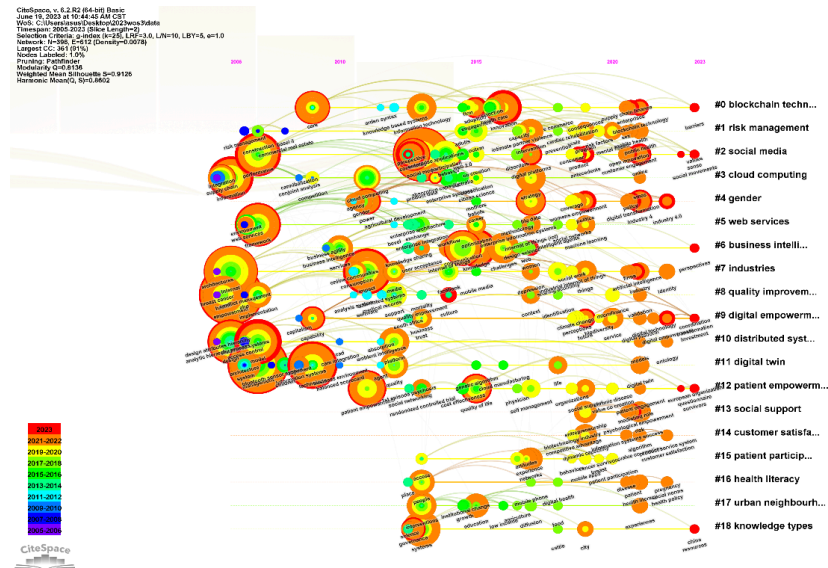


Figure 1. The timeline chart of keywords in international literature

As shown in Figure 1, international research literature on platform empowerment is largely concentrated after 2006. Among all identified keywords, the most frequently occurring include empowerment, management, social media, internet, technology, design, framework, and model. Further cluster analysis of the keywords revealed a total of 19 clusters. Based on temporal clustering results, the scope of research subjects in international studies has gradually expanded over time. Around 2006, topics related to technology and social media were concentrated, whereas by approximately 2017, the impact of platforms on individuals began to receive increasing attention. During this period, topics related to platform empowerment and consumer satisfaction developed alongside technology-centered discussions, showing a co-evolution of these research foci.

As shown in Table 1, international literature on platform empowerment exhibits several important characteristics. First, platform technologies have been explored and examined in depth. Among the 19 clusters, keywords such as cloud computing, web services, and blockchain technology occur with relatively high frequency. Second, regarding the categories of research subjects, compared with domestic studies, government actors are less frequently considered as primary research subjects in international studies. Third, in terms of mechanism and pathway research, international studies tend to focus more on the enhancement of specific business activities, such as product development, competition, customer engagement, knowledge management, and data sharing. Fourth, from the theoretical perspective, the term "systems" appears most frequently. Research mainstreams emphasize the interactions among multiple actors and the formulation and testing of hypotheses concerning environmental complexity.

Table 1. Classified clustering results of English literature keywords

Cluster	Cluster tags	Topic Initial Time	Research subject keywords	Mechanism-path keywords	Theoretical perspective keywords	Research methodology keywords
cloud computing	3	2006	Information,demand, supply chain,environmental uncertainty,product data	product development, competition, data sharing	absorptive capacity, enterprise systems, strategy	
Industries	7	2006	Internet, facebook, media,industry,social work,	consumer empowerment		
	8	2006	firms, mobile media,industrial internet of things, buyer-seller relationships,medical records,context	quality improvement, validation		
quality improvement						
distributed	10	2006	Platform, distributed systems,ontology. application service provision (asp), model	collaborative product conceptualization, collaboration, capacity		
Systems risk management	1	2007	Anxiety, mental health, commercial real estate, decision making,assistive technology,risk factors			
social media	2	2007	Community,behavior,enterprise applications,social Media, rights,digital platforms	customer engagement, knowledge management, social movements	open innovation	Classification, reviews,
			Environment,information model			
web services	5	2007	enterprise integration,web services enterprise	step standard, distributed product development, business continuity	Machine learning	comparative keyword analysis, general Sorting,
	11	2007	information systems,commitment,computer hardware			
digital twin					knowledge based systems	Methodology, balanced scorecard, content analysis, process
blockchain technology	0	2009	Adoption, care, firm, innovation, engagement, infommation technology,customization,market, health care, supply chain finance, human rights	market orientation,conceptual framework		
Digital empowerment	9	2009	digital platform, capitalism,digital technology	digital empowerment,	capability	
business intelligence	6	2010	business intelligence, services, communication, women	business agility, user acceptance	knowledge sharing,	analytics, analytical target
gender	4	2011	Agency,age,industry 4,mothers,	agriculture development,politics	design science	Cascading, questionnaire, search
patient empowerment	12	2011	Beliefs, self-help groups, gender, equality, quality of life, self management,social support			
	15	2014	cancer survivors, awareness, attitudes,adherence,	value co-creation, randomized controlled trial, patient engagement, patient participation	information systems success	
patient participation	16	2014	networks,behaviors,mobile apps			
health literacy	17	2014	People,disease,mobile phone primary care, institutional change, low income			
urban neighbourhoods	18	2014	Governance, systems,city		resources	
knowledge types						
Social support	13	2019	Entrepreneurship, work, moderating role, association, school,society	Business models, psychological empowerment, risk, job performance scale development, customer satisfaction, value co-creation	dynamic capability, competitive advantage	
customer satisfaction	14	2019	product service system,biotechnology industry, networking, information systems success			

3. Definition and characteristics of platform empowerment

The conceptual development of platform empowerment has progressed from "authorization" to "empowerment", with an intermediate stage of "delegation of power" [5, 6]. Currently, the concept of "empowerment" is also showing a trend toward "enabling" [7]. Owing to the earlier rapid development of consumer Internet platforms, early studies on platform empowerment primarily focused on the consumer domain [8]. The accumulation of data and technology in the consumer Internet platform sector has driven the extension of Internet platforms toward industrial and enterprise-oriented Internet applications. Consequently, new forms of empowerment, such as "data empowerment" and "technology empowerment", have emerged. At present, platform empowerment is characterized by extensive connectivity [9], data-driven processes [10, 11], and value co-creation [12-14]. Platform empowerment activities and the effective operation of digital business ecosystems are mutually reinforcing. On the one hand, the concept of digital business ecosystems inherently embodies a successful integration of technological and platform perspectives [15]. On the other hand, in practical operation, the technological support and platform-centered value creation logic of digital business ecosystems distinguish them clearly from traditional business ecosystem models.

Regarding the definition of platform empowerment, while referencing prior studies and viewpoints, this study takes into account the diversity of contemporary Internet platforms. Platform empowerment is defined here as the process by which a platform, by providing comprehensive technological services, continuously engages participants in the digital business ecosystem in production, innovation, and competitive activities, thereby promoting the integration and optimized allocation of resources between the platform and ecosystem participants [16]. Based on the results of the visualized analysis of platform empowerment research, this study summarizes the following characteristics of domestic and international research on platform empowerment:

3.1. Research subjects of domestic and international studies on platform empowerment are broad, with platforms exhibiting diverse characteristics

Within the ecosystem of participants, platforms occupy a central position. Users on the platform, stakeholder enterprises, and government agencies can all be included within the scope of platform empowerment research. The interactions among these actors, centered on the platform, serve as a crucial entry point for unpacking the "black box" of platform empowerment mechanisms.

In terms of the coverage of research subjects, there is substantial overlap between domestic and international studies, with both addressing consumers, platform ecosystem participant enterprises, platform enterprises, and government actors. Domestic research is influenced by trends in digital transformation, where governmental digitalization has given rise to topics such as digital governance. In this context, the government assumes a dual role as both the maintainer of the business environment and an active participant in commercial activities. In international research, greater emphasis is placed on the government's role in market regulation.

The focus of platform empowerment research has expanded from the consumer Internet domain to the industrial Internet and enterprise-oriented Internet [17]. Consumer Internet platforms aim to address consumer demand while simultaneously capturing value for themselves. The industrial Internet emphasizes the deep integration of next-generation information and communication technologies with industrial economic activities. The enterprise-oriented Internet encompasses an even broader concept than the industrial Internet, transcending the limitations of the industrial sector, embedding digital transformation across various industries, and ultimately driving digital transformation across society. Digital government represents a key application scenario within the enterprise-oriented Internet [18].

3.2. Interactions among platform empowerment subjects focus on "value", with complex interrelationships

The ultimate outcome of platform empowerment is consistently centered on "value". Keywords such as value co-creation occur with high frequency in both domestic and international literature. However, the focus of pathway analyses differs between domestic and international studies. In international research, the pathways of platform empowerment are examined from the perspective of management experience, identifying specific pathways such as customer satisfaction and quality improvement. By contrast, domestic studies describe empowerment pathways in a more abstract manner, including structural empowerment, psychological empowerment, and digital empowerment. Domestic research also places greater emphasis on the dynamic alignment of these pathways with enterprise development, highlighting the synergistic effects of various empowerment mechanisms [19].

3.3. Broad research perspectives: adopting an ecosystem view as the entry point for framework construction

This study adopts the macro-level theory of digital business ecosystems as the primary theoretical perspective for constructing the research framework. Unlike traditional business ecosystems, digital business ecosystems emphasize the impact of technology, which can be decomposed into two logical systems: the data system and the business value system [20]. This aligns with the characteristics of platform empowerment research, in which the platform serves as the technological core and value creation constitutes the ultimate focus. Based on this perspective, this study constructs a theoretical framework following the three-tier structure of value nodes—value chains—value networks. From an ecosystem perspective, the external environment is considered an integral component of the overall system. The study will discuss, across these three levels, (1) the diversity of research subjects, (2) the operational mechanisms of individual platforms, and (3) the current operational status of digital business ecosystems composed of multiple interwoven platforms.

4. Construction of a research framework for platform empowerment theory from the perspective of digital business ecosystems

The concept of business ecosystems was first proposed by Moore (1993), who defined a business ecosystem as an economic community composed of loosely coupled interactions among organizations and individuals that generate valuable goods and services [21]. In the era of the digital economy, the construction of business ecosystems is increasingly influenced by technological development, giving rise to the concept of digital business ecosystems (DBEs). Technological centrality constitutes the primary distinction between digital business ecosystems and traditional business ecosystems [22].

Digital business ecosystems are characterized by platform-centricity, symbiosis, co-evolution, and self-organization [23]. In a digital business ecosystem, the platform serves as the core and is regarded as a collection of tools and innovative services. The ecosystem also encompasses diverse platform actors.

Within digital business ecosystems, platforms facilitate extensive organizational-level linkages. Increasing heterogeneity among enterprises and the gradual blurring of geographical boundaries contribute to reductions in transaction costs and improvements in service quality within the ecosystem [24]. To a certain extent, interactions among different participants can move beyond zero-sum scenarios [13], with value co-creation emerging as the mainstream form of value generation in platform-centered digital business ecosystems.

From the perspective of the structural form of digital business ecosystem operations, the ecosystem can be divided into three levels: value nodes, value chains, and value networks [25]. These three levels exhibit a degree of symmetrical alignment [12]. Adopting the digital business ecosystem perspective and organizing platform empowerment theory according to the hierarchy of value nodes, value chains, and value networks allows for the inclusion of a sufficiently broad range of participants and empowerment pathways, while also considering the external business environment.

In the following sections, this study takes the digital business ecosystem as its starting point and attempts to construct an integrated theoretical framework for platform empowerment.

4.1. Value node level

In research on digital business systems, many scholars equate value nodes with individual enterprises [25]. However, the business development of individual users is also critical to the construction of platform ecosystems. Therefore, this study includes individual users within the scope of value nodes. At the value node level, the research objects consist of platform enterprises (hereafter referred to as platforms), enterprise users on the platform (hereafter enterprises), individual users, and government actors. Most research questions focus on changes in production, operations, and management processes brought about by platform participation.

Among all types of value nodes, platform enterprises occupy a dominant position. The establishment of platform enterprises is primarily influenced by technology and environmental factors, with the maturity of next-generation Internet technologies making platform construction possible [26]. Strong governmental support for digital transformation has facilitated significant development of platform enterprises related to digital transformation in recent years [27]. However, environmental factors alone are insufficient to guarantee platform construction; the co-creation process of platforms relies critically on trust among participants [28]. Platform ecosystems inherently possess openness, symbiosis, and collaboration [29]. Most platform enterprises develop gradually through three stages—platform architecture, platform services, and platform governance—while continuously discovering and expanding platform value throughout the development process [30]. As dynamically evolving nodes, the development of platform enterprises is driven by stakeholders and technological advances, and the value of a platform value node is manifested in its empowerment pathways to different nodes. During the consumer Internet era, marketing perspectives first emphasized the role of e-commerce platforms and social media platforms in enhancing consumer perceived value and improving enterprise performance [31]. Consequently, early descriptions of platform empowerment mechanisms focused on

organizational empowerment, employee empowerment, and leadership empowerment. Against the backdrop of the digital economy, some scholars proposed empowerment mechanisms better aligned with economic contexts, such as data empowerment and technology empowerment, arguing that platforms exert influence primarily through technology and data accumulated in daily activities [32]. As Internet development extended from the consumer Internet to the industrial Internet, the concept of "ecosystem" frequently appeared in studies of empowerment mechanisms at the industrial level. Some scholars argue that platform enterprises can exert ecological empowerment on ecosystem participants [33].

Research on enterprise value nodes primarily examines optimization of production and operational activities following platform intervention. Platforms expand the boundaries of enterprise resources, enhancing the quantity and quality of accessible data, technological, and cultural resources [34], thereby driving breakthroughs in organizational capabilities. Platform intervention can significantly improve firms' cross-boundary search capabilities [35], optimizing both internal and remote knowledge search activities. Such optimization may influence the enterprise growth process through ambidextrous innovation [36]. Additionally, a series of activities—including opportunity recognition, strategic decision-making, and organizational transformation and reconstruction [37, 38]—are enhanced, allowing enterprises to integrate deeply into digital ecosystems and substantially increase their competitive advantage [39].

Research on individual user value nodes primarily focuses on exploring user value and facilitating user authorization [31]. Studies of individual users are mainly concentrated in the social media domain [40]. Users are connected through platforms, and the presence of technological empowerment enhances the efficiency of their value-creating activities. Beyond traditional commercial activities, platforms also exert social influence, such as promoting feminist discourse and mobilizing movements around racial issues. Although individual user value nodes often occupy a weaker position within digital business ecosystems, individual users' attitudes toward platforms and technologies can still affect value creation activities within the ecosystem. Platform governance, maintained through user trust, represents a key direction for future research [41].

Research on government value nodes extends from studies on digital transformation in manufacturing enterprises, falling within the domain of digital transformation at the level of social governance. Platforms, through digital and technological empowerment, provide optimization solutions for governmental processes and have achieved notable results in areas such as grassroots governance and smart cities [42].

4.2. Value chain level

The value chain level involves interactions and exchanges among different value nodes. As shown in Figure 2, the construction of value chains primarily encompasses interactions and exchanges among data, innovation, and products.

The flow of data at the value chain level is a distinguishing feature of digital business ecosystems compared to traditional business ecosystems. Data is considered an advanced factor of production [43], and its reward characteristics vary across different contexts. Data empowerment constitutes a primary form of empowerment activity among nodes within digital business ecosystems. In value creation activities, at the enterprise level, data participates in business model innovation and opportunity discovery; at the government level, it helps enhance governance efficiency; at the individual user level, although data flows bidirectionally, the value of data cannot be fully realized due to the digital divide. In digitally transforming enterprises, barriers arising from the digital divide manifest as "intelligent upgrading and industrial integration barriers" and "ecosystem architecture barriers" [44].

In terms of innovation interactions, platforms, enterprises, and individual users can all engage in innovative activities. Empowerment activities between platforms and different value nodes generate value co-creation across areas such as employment and business models. Extensive connectivity transforms "empowerment" into "enabling", as interactions between individual users and enterprises increasingly foster self-organizing tendencies emerging from platform-centered business operations. The innovation chain incorporates multiple forms of empowerment, including psychological empowerment, structural empowerment, and authorization empowerment. Platforms influence enterprise power structures through authorization, leadership, and psychological empowerment [45]; optimize internal operational processes through knowledge and technological empowerment, addressing challenges such as digital transformation and resource constraints to enhance operational efficiency [46, 47]; and improve enterprises' crisis-handling and survival capabilities through forms such as digital-intelligent empowerment [48]. Synergistic innovation occurs between platforms and enterprises when alignment exists among motivation, capability, and environment, ultimately achieving co-innovation [49]. Innovation activities between platforms and individual users are primarily driven by emerging employment forms, such as the gig economy and crowdsourcing. Platform empowerment for individual users is mainly realized through authorization and psychological empowerment. The integration of virtual and physical industries generates vast amounts of data, and leveraging data analytics enables breakthroughs in niche market discovery, customer demand identification, decision support, and product innovation [50], thereby increasing individual users' influence in commercial activities.

Product chain activities primarily occur between production enterprises and individual users, involving the optimization and upgrading of supply chains under the platform economy. Platforms can reduce supply chain costs through supply chain

empowerment [51], and provide supply chain optimization during enterprise product innovation, promoting value co-creation among technology developers and suppliers [47].

In addition to interactions among different types of nodes, interactions also occur within the same type of value node. Research on internal competition and cooperation among different enterprises is key to understanding competitive activities within digital business ecosystems. Some scholars analyze this competitive-cooperative relationship from the platform perspective, arguing that examining platform scale and platform identity as strategic dimensions is essential for understanding the nature of digital market competition. Platform boundaries and competitive dynamics lead to shifts in competitive arenas and redefinition of market boundaries [47]. As digital business ecosystems mature, complementary platforms are increasingly attracted, and these complementors compete within ecosystems characterized by network effects, semi-regulated structures, and collaborative modes [52, 53].

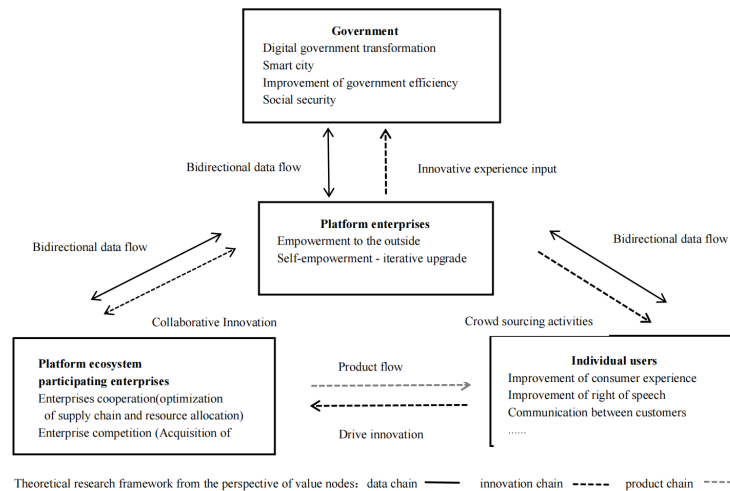


Figure 2. Interpersonal interaction relationships at the value chain level

At the value network level, participants within the value chain engage in interactions involving data, innovation, and products, while enterprises of the same value node type also exhibit complex competitive and cooperative relationships. As participant diversity increases, the scale effects of platforms become increasingly evident. As illustrated in Figure 3, the sequential development of consumer Internet, industrial Internet, and industrial Internet sectors interweaves different industries. Connections among various types of platforms form a vast digital business ecosystem. At the ecosystem level, the primary form of empowerment is ecological empowerment. Ecological empowerment originates from the extensive linkage of actors and scenarios facilitated by platforms. Based on these linkages, cross-boundary business coordination within the ecosystem enables multilateral value co-creation activities [54, 55]. A series of institutional and incentive arrangements centered on platform governance further ensure the effective operation of empowerment activities within the business ecosystem [56, 57].

Traditional industrial ecosystems rely heavily on the geographic clustering of industries [58]. In line with the development of digital business ecosystems, the concept of virtual industrial agglomeration has emerged. Virtual industrial agglomeration depends on remote connectivity and real-time data access enabled by Internet technologies and arises from the interactive flows of data chains, innovation chains, and product chains, representing a trend in industrial development. However, a unified understanding of "virtual agglomeration" has yet to be established. Some scholars view it as a form of connection that reduces communication and supply chain costs in traditional industries, thereby diminishing the necessity of geographic clustering [59]. Others argue that virtual industrial agglomeration is more than a mere "distance reduction" through platform linkages; it may also promote geographic clustering to some extent, as firms involved in virtual agglomeration often rely on network technology spillover effects, making geographic clustering near universities, research institutions, and leading platform enterprises more likely [60]. This study interprets virtual and geographic agglomeration in terms of the form of industrial linkage, without considering geographic clusters emerging from virtual agglomeration as part of virtual agglomeration itself. Nevertheless, it acknowledges that under the platform economy, virtual industrial clusters and geographic clusters inevitably develop in a coordinated manner. During virtual industrial agglomeration, similar institutional logics are necessary to support enterprise growth [61]. Research on the similarity of institutional logics across different types of enterprises and industries remains limited, and how platforms overcome constraints to achieve value co-creation also lacks sufficient explanation.

The operation of value networks similarly requires the construction and maintenance of the environment. Xiao et al. argue that platform enterprises, as the core of ecosystems, should design comprehensive governance schemes at the individual, contextual, and systemic levels [62]. Other scholars, adopting a multi-actor perspective, suggest that platform governance can

enhance innovation performance in digital business ecosystems by strengthening cognitive trust, institutional trust, and identification-based trust among system members [63].

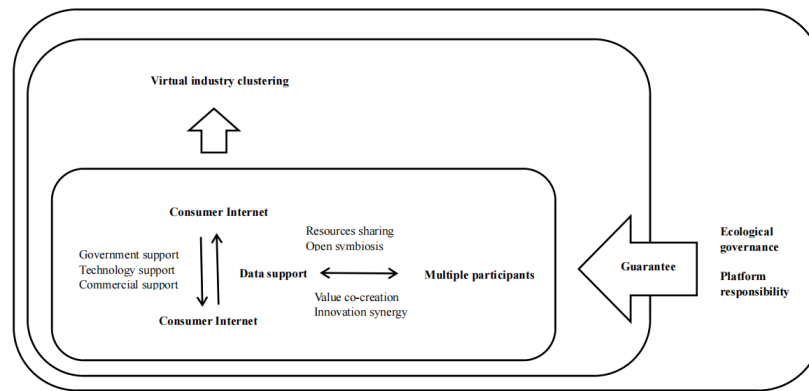


Figure 3. The development trend and operational guarantee system of the relationship among entities at the value network level

5. Future research directions

First, at the value node level, the applicability of platform empowerment theory to different types of platforms requires further exploration. Current research clearly indicates a developmental trend from consumer Internet to industrial Internet and then to industrial Internet sectors [64]. Topics such as value co-creation and data empowerment in the consumer Internet domain, integrated with the recent digital transformation context, provide important theoretical explanations for industrial Internet platform empowerment. When studying mechanism pathways, the consideration of platform heterogeneity represents a key area for future research. It remains to be clarified whether empowerment pathways such as structural empowerment and psychological empowerment manifest differently across various platforms and what specific characteristics these differences entail.

Second, at the value chain level, cross-platform innovation behavior in value co-creation requires more in-depth analysis and interpretation. Based on existing studies, this paper summarizes three types of interaction activities among participants upon which platform empowerment depends: data chains, innovation chains, and product chains. These activities occur simultaneously or sequentially over time, forming organic linkages among participants in digital business ecosystems. Different enterprise actors linked on the same platform can engage in value co-creation through effective information exchange [2]. However, whether such symmetric value co-creation exists among platforms connected to the same enterprise actor has not been sufficiently explored. Expanding research on cross-boundary value co-creation among more value nodes will deepen understanding of competition and cooperation among platforms and improve the description of the flow of data chains, product chains, and innovation chains within the theoretical framework presented in this paper.

Finally, the tendency for virtual industrial agglomeration generated by platform empowerment represents a major trend distinguishing digital business ecosystems from traditional business ecosystems. Virtual industrial agglomeration relies on network-based communication and linkage, making it less intuitive than geographic clustering and difficult to measure [65]; thus, the academic community cannot yet definitively confirm its occurrence. Furthermore, with the continuous development of technologies such as blockchain, decentralized organizations are emerging. Whether such changes at the node level might generate forces at the value network level that counteract the trend of industrial agglomeration remains to be further investigated.

6. Conclusion and implication

Based on the visualization analysis and systematic synthesis of 1,021 Chinese-language and 1,034 foreign-language publications, this study constructs a theoretical framework for platform empowerment research from the perspective of digital business ecosystems. In Section 2, the research status of platform empowerment theory was summarized and categorized at three levels: value nodes, value chains, and value networks. Through systematic review, the study finds that platform empowerment deeply participates in value creation activities within digital business ecosystems. Moreover, platform empowerment activities constitute a key distinguishing feature of digital business ecosystems compared with traditional business ecosystems. The main conclusions of this study can be summarized in the following three points:

First, at the value node level, platform empowerment involves diverse participants, primarily platform enterprises, ecosystem participant firms, individual users, and government agencies. In domestic research, governments act as recipients of platform empowerment through activities such as digital governance, whereas international research places greater emphasis on the government's role as a market regulator. Differing from traditional business ecosystems, the value nodes in platform-centered

digital business ecosystems also incorporate technology-intensive platforms and firms providing technical support into the discussion.

Second, the interactions among value nodes and the competitive and cooperative relationships among firms within value nodes together form a complete platform empowerment value chain. The development of Internet technologies has facilitated the formation of data chains, and the flow and utilization of data have further established data as a critical production factor in the digital economy. The value generated through platform empowerment flows along the data chain, innovation chain, and product chain. Empowerment pathways such as data empowerment, psychological empowerment, authorization empowerment, and structural empowerment can individually or collectively promote value creation among enterprises along the chain. However, in current research, bidirectional value co-creation has not been fully explored across all nodes.

Third, as platform participants become increasingly diverse, ecological empowerment emerges as a representative pathway. Enterprises leverage network technologies to form virtual industrial agglomerations, which are maintained through platform ecosystem governance, thereby promoting innovation and enterprise development [66, 67]. The emergence of virtual agglomeration represents a distinctive developmental trend that differentiates digital business ecosystems from traditional business ecosystems.

Research on platform empowerment has developed considerably to date, yet a systematic theoretical review remains lacking. This study takes this gap as a starting point, organically integrating existing theories to propose a three-level theoretical framework of platform empowerment, comprising value nodes, value chains, and value networks. Based on this framework, this paper summarizes and outlines potentially valuable directions for future research at each of the three levels. At the value node level, platform empowerment theory requires deeper discussion regarding the differences in empowerment activities across various types of platforms. At the value chain level, whether value co-creation occurs among different types of platforms remains to be further observed and explored. Meanwhile, the directional flows of data chains, innovation chains, and product chains may be further refined as research on cross-actor value co-creation advances. At the value network level, it is worthwhile to closely monitor whether the development trend of virtual industrial agglomeration, driven by platform empowerment activities within digital business ecosystems, will be impacted by decentralized technologies such as blockchain.

However, this study has several limitations. First, the discussion of Internet technology characteristics of platform empowerment is limited. Platforms embody a series of advanced technologies, and the topic of platform empowerment inherently has a strong interdisciplinary nature. Yet, during the literature screening process, the search scope was primarily confined to the social sciences, leaving the technological features of platform empowerment insufficiently summarized and explored.

Second, regarding the value chain level, the flow directions of the data chain and innovation chain depicted in this study represent only the synthesis and summary of the literature currently available. They do not imply that bidirectional innovation activities between governments and platforms, or bidirectional data flows between platforms and individual users, are absent in real-world business operations. As platform empowerment research progresses, the identification and resolution of additional managerial challenges may provide further refinement and supplementation of the directional flows in the value chains outlined in this study.

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