

Review of Research on the Platform's Ecosystem

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Abstract: *Under the background of digital economy, platform ecosystem, as a new organizational paradigm, plays an increasingly important role in the development of economy and society. Through the literature review method, this paper proposes that the connotation of platform ecosystem has the characteristics of modularity, network effect, and complementarity based on the explanation of the connotation of platform ecosystem according to industrial organization economics perspective, strategic management perspective, and technology management perspective, and analyzes the competitive relationship of platform ecosystem; finally, it puts forward the two research theme trends of the complementary and dependent relationship of platform complementaries and the innovation of platform business model, with a view to provide useful references and lessons for the theoretical research and practical activities of platform ecosystem.*

Keywords: *platform ecosystem, platform, complementarians, platform cooperation*

1. Introduction

With the development and popularization of emerging technologies such as the Internet, big data, and artificial intelligence, traditional enterprises "leveraging" digital platforms for empowerment is considered an ideal path to promote digital transformation (Chen Weiru et al. 2021)^[1]. As more and more enterprises begin to operate on a platform, a platform ecosystem is gradually formed with the platform enterprise as the core, with the platform enterprise setting the interface rules, opening up the architecture to attract complementary players to enter, and jointly providing products and services for users (Adner, 2017)^[9]. In fact, whether it is Apple, Microsoft, Google, Alibaba, Tencent and other Internet platform enterprises, or other platform enterprises that extend and develop into finance, logistics, manufacturing and other industries, their value creation is based on the platform ecosystem (Kapoor et al., 2021)^[20].

The platform ecosystem takes the platform owner as the core, and attracts a large number of high-quality participants to provide value-added services for the platform through shared or open-source technology standards, so as to attract users and consumers to obtain profits (Jacobides et al., 2018)^[19]. It can be seen that a complete platform ecosystem includes not only the platform owner, but also platform complementors and users who join the existing platform ecosystem in order to obtain the dividends of rapid ecological expansion. All stakeholders play different roles and play different roles in the system, and the whole platform ecosystem constitutes an interdependent and co-growth value creation and value distribution network. In the process of building the ecosystem, some platform enterprises have continuously promoted the development and growth of the ecosystem by exerting the platform network effect and establishing positive interaction and cooperation with supply-side, demand-side and other stakeholders, such as Xiaomi's construction of the world's largest LOT platform ecosystem for smart hardware within three years through its business incubation platform, which has created a growth miracle (Zhang Huayao et al., 2021)^[6]. However, there are also some enterprises struggling on the edge of profitability, or even being blocked and eliminated, such as the failure case of LeTV. The key to the reason why some enterprises succeeded while others failed lies in the value creation process of the platform ecosystem that is jointly realized between the platform owner and the platform participants (including complementarities and users) through competition and cooperation (Zhong Qi et al. 2021)^[7].

Therefore, through the literature review method, this paper comprehensively combs through the platform ecosystem literature research overview, analyzes its concept, characteristics, competition and cooperation, research development trend, with a view to providing scholars in the field of platform organization and value co-creating research with references and reference to grasp the research overview, key issues and development trend.

2. Concept of a platform ecosystem

The term "ecosystem" is borrowed from biology and usually refers to a number of interacting firms that depend on each other's activities. As a platform-mediated ecosystem, platform ecosystems have been diversified in different disciplinary contexts and research frameworks, and the existing literature mainly explains the concept of platform ecosystems from an industrial organization (IO) economics perspective, a strategic management perspective and a technology management perspective.

2.1. Perspectives on the economics of industrial organization

A platform ecosystem, from an industrial organization economics perspective, is essentially a multilateral market structure constructed by platform firms that connects multiple user groups, such as producers, consumers, and service providers (Rochet & Tirole, 2003)^[26]. In this unique market environment, platform firms capitalize on bilateral or multilateral network effects, i.e., growth in user size leads to an increase in the overall value of the platform, which may lead to the formation of market power (Caillaud & Jullien, 2003)^[12]. The perspective of industrial organization economics emphasizes the existence of direct and indirect network effects in different contexts and the subsequent emergence of dominant platforms (Shapiro, 1999; Parker & Van Alstyne, 2005)^{[25][23]}. Direct network effects refer to the fact that the benefits of a user's participation in a network depend on the number of other network users with whom they can interact, and the greater the number, the stronger the direct network effects (Eisenmann et al., 2006)^[13]; whereas indirect effects refer to the fact that they occur when the size of the user group on one side can benefit from the size and characteristics of the user group on the other side (Evans, 2003; Parker & Van Alstyne, 2005)^{[14][23]}.

2.2. Strategic management perspective

This perspective views the platform ecosystem as a structured set of interested partners who maintain full interaction with the goal of achieving a common value proposition (Kapoor et al., 2021)^[20]. Strategic management scholars emphasize the emergence and persistence of competitive advantage in these environments. Competitive advantage arises when firms provide greater value to customers at a lower cost than competitors (Porter, 1985)^[24]. In platform intermediation environments, competitive advantage is strongly dependent on the ability of platform firms to stimulate co-creation of value with their complementary networks (Adner & Kapoor, 2010)^[8] and to capitalize on the ensuing positive feedback dynamics (Katz & Shapiro, 1986)^[21].

2.3. Technology management perspective

This perspective describes platform ecosystems as technological architectures (Gawer, 2014)^[17], defining platforms as core and complementing peripheral components, and facilitating interactions between platforms and complementary components through public interfaces on which platform owners and complementors seek to innovate. Research from the technology management perspective focuses on platform owners, particularly how they attract third-party complementarities, such as the openness of platform interfaces-how they influence innovation through their ability to attract third-party complementarities (West, 2003; Boudreau, 2010)^{[30][11]} to stimulate indirect network effects (Eisenmann et al., 2006)^[13].

In summary, each of the research streams described in the previous sections provides important insights for us to understand the evolution of the platform ecosystem, while this paper argues that the platform ecosystem is a complex business ecosystem centered on the platform enterprise and aggregating supply-side, demand-side, and other multi-stakeholder subjects, in which there exists a very complex value relationship between all stakeholder subjects, and at the same time, the dynamic and complex interactions among them drive the evolution of the entire ecosystem. In the platform ecosystem, there exists a very complex value relationship among the stakeholders, and at the same time, the dynamic and complex interaction activities among them drive the evolution of the whole ecosystem.

3. Characterization of the Platform's ecosystem

Due to its special characteristics, the platform ecosystem is characterized by modularity, network effect, complementarity and dependency.

The organizational structure in the platform ecosystem presents modular characteristics, such as internal teams, partners, and user communities forming relatively independent but synergistic organizational units, which work together to promote the innovative development of the platform ecosystem through flexible task allocation, knowledge sharing, and complementary capabilities (Benner et al., 2015)^[10]. The modular platform architecture frees developers in the ecosystem to refine their complementary products, while the platform interface enables them to interact smoothly (Tiwana, 2015)^[29].

The network effect in the platform ecosystem refers to the phenomenon that the value of the platform shows a non-linear growth with the increase in the number of users, and is one of the core features that distinguish the platform economy from traditional economic models. Platform network effects can be categorized into direct effects (e.g., direct communication and interaction among users) and indirect effects (e.g., increase in complementary products or services). Direct network effects usually occur between users on the same side, such as the increase in the number of friends in a social network, while indirect network effects occur between different groups of users, such as the increase in the number of buyers in an e-commerce platform that attracts sellers (Eisenmann et al., 2006)^[13].

A central feature of platform ecosystems is complementarity (Adner, 2017; Jacobides et al., 2018)^{[9][19]}. Complementarity is interpreted as the degree to which two or more assets fit into each other, i.e., the degree to which the combination of the two generates value (Jacobides et al., 2006)^[18]. In the platform ecosystem context, Jacobides et al. (2018)^[19] categorize complementarities into transactional and innovative complementarities: transactional complementarities are where two products or services cannot function without the same, resulting in a loss of value. Innovation complementarity, on the other hand, is the ability of two products or services together to create greater value than each. It is precisely because of functional and technological complementarities that the different participants in the platform (e.g., platform enterprises, users, third-party developers, suppliers, etc.) come together to form an organic whole.

4. Competitive relationships in the platform ecosystem

The platform ecosystem provides a good cooperative environment for multi-objects to create value and expands the profit space of each stakeholder, and this dependent collaborative relationship is also an important foundation of the platform ecosystem. However, in reality, the market purpose of each subject in the platform ecosystem is not completely consistent, and they all try to pursue their own profits in the process of collaboration, so there is both cooperation and competition in the process.

First, the platform owner may compete with the complementor by entering the complementor's market. Due to the platform's own reputation advantage and cost advantage, even if the quality of the complementary products provided by the platform firm is lower than that of the original complementizer, users may choose the complementary products provided by the platform firm, which reduces the value capture ability of the complementizer (Wen & Zhu, 2019)^[31], and thus there exists a competitive relationship between the two. However, the platform owner's entry into the complementary market expands the total number of consumers attracted to a market category, generating positive spillover effects on similar products (Liu et al, 2015)^[22], which will motivate complementors to respond positively and flexibly to changes in the external market (Foerderer et al. 2018)^[15], and there is again a collaborative relationship between the two at this level.

On the other hand, at the user level, the relationship with platform owners and complementors is more cooperative. Users can comment or rate the products after using the products of complementors and platform owners, and complementors and platform owners may reiterate and update the products according to the users' opinions after receiving the feedback from the users, and the appropriate transformation and upgrading of the products can enhance the users' consumption willingness and the perceived value, so that the users can obtain new value services, which can enhance their satisfaction and experience of the products, and can also improve the product performance (Su Wan et al., 2020)^[3]. Therefore, the relationship between users and platform owners and between users and complementors is mainly cooperative.

5. Research trends in platform ecosystems

Complementary and dependent relationship of platform participants: the platform ecosystem provides a good cooperative environment for value co-creation between multiple subjects, the platform provides

a trading space for complementarians, complementarians provide complementary products for the platform, and both parties form a cooperative relationship in the platform ecosystem and acquire value. It has been argued that the core feature of the platform ecosystem is complementarity (Teece, 2018; Jacobides et al., 2018)^{[28][19]}, and the higher the degree of complementarity of complementors to the platform enterprise, the more they can create value for the ecology, and naturally, they can obtain high income and high profits. However, for the complementizer to enhance its complementarity to the platform firm, it means that the complementizer has to make a large investment in the partnership with the platform firm, which will also enhance the complementizer's dependence on the platform firm. The complementizer is in a weak position with asymmetric power and lacks bargaining power to profit from the ecosystem led by the platform firm even if it is highly complementary to the platform firm. Further, a complementizer that wants to reduce its dependence on the platform firm implies that it needs to reduce its motivational investment, which diminishes the complementizer's ability to develop products and services for the platform ecosystem, and thus reduces its complementarity to the platform firm. As a result, complementors will easily fall into the coupling dilemma that raising complementarity will raise dependence and lowering dependence will lower complementarity, and will be in an unfavorable position of right and left dilemma. Therefore, how the complementors of the platform can improve their complementarity to the platform and reduce their dependence on the platform has become a direction for future research. At present, Wang Jiexiang, Chen Weiru et al. (2021)^[5] summarize three decoupling strategies, including multiple identity strategy, multi-habitat customization strategy, and platform mosaic strategy, through three case studies of Hantu Yishe, Mushroom Street, and Yunjie, and reveal the decoupling mechanism of the three strategies to enhance the complementarity and reduce the dependence. At the same time, Chen Weiru and Wang Jiexiang (2021)^[1] analyze the case study of collaborative upgrading of the design enterprise Rococo Group and Nail Platform, analyze the process of Rococo Group's cooperation with Nail through the three stages of intergration, symbiosis, and autonomy to gradually reduce the dependence on the Nail Platform and enhance complementarity, and put forward the "Dependent Upgrading" model of ecological complementarities to promote the digital transformation with the help of platform enterprises. The model of "dependent upgrading" is proposed.

Platform business model innovation: Business model innovation for platforms is an important way for platform ecosystems to realize value co-creation, and a large number of scholars have emerged to study business model innovation, and many contributions to the literature have led to the concept of a business model that now provides a firm's "design or architecture of mechanisms for creating, delivering, and capturing value" (Teece, 2010)^[27]. Whereas, firms engage in business model innovation as designed, novel, and significant changes to the key elements of the firm's business model and/or the architecture that connects these elements (Foss & Saebi, 2017)^[16]. A current study by scholars Tian Jian and Xu Jiabin (2020)^[4] from the perspective of business model innovation drivers of platform-based enterprises proposes that big data capabilities, bilateral market efficiency coefficients, and service quality coefficients of platform-based enterprises are the key drivers of business model innovation of platform-based enterprises. In recent years, the rise of a large number of emerging platform models has also provided a wealth of case samples for the study of platform business model innovation, for example, Jiang Jiehai and Li Qin (2016)^[2] explored the impact of connectivity attributes on value co-creation through the study of the business model innovation of Airbnb online short-term rental platform. Scholars have carried out a large number of practical studies with the help of specific platform enterprise cases to explore the process and mechanism of platform business model innovation in specific fields.

6. Conclusions

Platform ecosystem research is a rapidly growing research field in recent years based on platform theory and enterprise ecosystem theory with the booming development of digital economy, sharing economy and platform economy, which has become a research hotspot in academia and a need for practical development. This paper, by systematizing and combing the existing researches, obtains the following conclusions:

(1) Through combing and analyzing the relevant foreign literature on platform ecosystem, this paper sorts out and defines the connotation of platform ecosystem from the perspectives of industrial organization economics, organization management, and technology management, proposes that the platform ecosystem has the main features of modularity, network effect, and complementarity, and analyzes the competition and cooperation among platform owners, complementaries, and users in the context of platform ecosystem, and finally puts forward the future development of platform ecosystem. It also analyzes the competition among platform owners, complementaries and users in the context of platform ecosystems, and finally puts forward the future research trends of platform ecosystems.

(2) Platform ecosystem research has a lot of space for cross-disciplinary research, and the existing research direction can be further explored by combining theories, methods and new research perspectives of other disciplines. For example, for the research of “platform ecosystem competition relationship”, we can study the dynamic competition relationship between subjects on the evolution of platform ecosystem and the influence mechanism of platform value co-creation from the perspective of dynamics and networking, combined with the theory of organizational network and complex network theory and methods.

(3) The emergence of a large number of new platform models under the digital economy and platform economy has provided a rich research background for platform ecosystem research, and the rapid development of big data and Internet technology has also provided massive data support for the research, which has further broadened the scope of the research, and there is an opportunity to obtain more innovative research results by combining data-driven research paradigm in the future.

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