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Research on dynamic mechanism of cross-border e-commerce ecosystem evolution

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Abstract
The popularization of information technology and the improvement of global commercial infrastructure, such as finance, communication, and logistics, have facilitated the flourishing development of cross-border e-commerce. Tens of thousands of different types of participants, including cross-border e-commerce platforms, manufacturers, distributors, and logistics service providers, have formed a cross-border e-commerce ecosystem similar to a natural ecological system. This study attempts to explore the driving mechanisms that promote the evolution of cross-border e-commerce ecosystem from its inception to maturity, and provide references for relevant research and practice. Based on a review of literature and practical experience of cross-border e-commerce enterprises, this study selected the driving mechanisms of the evolution of the cross-border e-commerce ecosystem as the research object. Based on theories such as transaction cost theory, industry chain theory, self-organization theory, and symbiosis theory, and using normative analysis, the driving mechanisms of the evolution of the cross-border e-commerce ecosystem are summarized as follows: rule mechanism, contract mechanism, self-organization mechanism, collaborative mechanism, profit distribution mechanism, competition mechanism, innovation mechanism, and cooperation mechanism. This provides a theoretical framework for case verification in later sections. Based on the theoretical framework and combined with the case study of AliExpress, a typical practice of constructing the cross-border e-commerce ecosystem, this study proved that the driving mechanisms generate power and drive the AliExpress ecosystem to evolve, further demonstrating the objectivity of the theoretical model.

Key words: Cross-border e-commerce; Business ecosystem; Evolution; Dynamic mechanism

1 Introduction

With the deepening of economic globalization and the increasing perfection of

infrastructure such as the internet, communication, logistics, and finance, cross-border e-commerce has emerged as a new force. Its market and transaction volumes have rapidly expanded and maintained a high-growth trend, which is in stark contrast to the weak growth of traditional international trade. However, different from traditional international trade in goods and domestic e-commerce, cross-border e-commerce has its characteristics and complexities in development. Conducting business activities under an international background, cross-border e-commerce involves many participating entities, with at least two economic entities from different countries or regions engaging in transaction activities. The complexity of these transactions is increased by factors such as cultural background, payment methods, language communication, cross-border logistics, and credit guarantees. Any changes in any of these links can affect the progress of cross-border transactions. The competition of cross-border e-commerce is no longer limited to the needle-pointed rivalry between individual enterprises, but is now focused on the competition between ecosystems centered around cross-border e-commerce platforms. The quality and quantity of resources such as information, funds, technology, and services around the core platform have become the core of ecosystem competition today. Therefore, participants in the ecosystem need to find the appropriate path to construct a cross-border e-commerce ecosystem based on their resource characteristics. In practice, both domestic and foreign cross-border e-commerce enterprises are building ecosystems around their core businesses and resources.

With the advancement of internet coverage, the acceleration of infrastructure improvement in various countries, and the global flow of capital, cross-border e-commerce has grown rapidly. Based on the analysis of China's domestic e-commerce and existing leading cross-border e-commerce platforms' evolutionary trends and typical cases, ecosystem or systematic development is becoming the trend of cross-border e-commerce. The participating entities are constructing complete cross-border e-commerce ecosystems around business flow, logistics, information flow, fund flow, and core platforms. However, besides clarifying the members of the cross-border e-commerce ecosystem, the evolutionary driving mechanism is another urgent problem that needs to be solved. Therefore, this paper takes the driving mechanism of the evolution of the cross-border e-commerce ecosystem as the research object, summarizes the driving mechanism of the evolution of the cross-border e-commerce ecosystem upon constructing the ecosystem, and attempts to provide theoretical and practical references.

This paper constructs a theoretical model of the driving mechanism for the evolution of the cross-border e-commerce ecosystem, clarifies the driving mechanism of the evolution of the cross-border e-commerce ecosystem, and analyzes the composition of members of the ecosystem and their interaction. Additionally, Alibaba's AliExpress is taken as a case study to test the driving mechanism of the evolution of the cross-border e-commerce ecosystem. The objective nature of the theoretical model is

verified through case demonstration, providing theoretical references for cross-border e-commerce enterprises in China. From the governance level, it provides decision-making reference for policy-making and governance of decision-making departments and regulatory agencies to promote the development of cross-border e-commerce. From the micro-level of the subject, it provides micro-theoretical support for cross-border e-commerce platform development and theoretical support for cross-border e-commerce enterprises to build or govern cross-border e-commerce ecosystems.

2 Literature Review and Theoretical Basis

2.1 Research on the Connotation of Cross-border E-commerce Ecosystem.

The exploration of the evolutionary driving mechanism of cross-border e-commerce ecosystem is a deeper research of cross-border e-commerce and the ecosystem itself. Before this, domestic scholars have already achieved some results in the research areas related to the cross-border e-commerce ecosystem, such as the connotation and construction mode of cross-border e-commerce, development paths and member collaboration, external environment and its development relationship, as shown in Table 1.

Table 1 Some Chinese scholars' research on cross-border e-commerce ecosystem

Author	Research Angle	Main content
Zhang Xiaheng(2016) Zhang Henan(2020)	The construction of ecosystem	The collaboration of members is the key to building a cross-border e-commerce ecosystem
Qian Huimin(2017) Cao Wujin(2019) Xue Chaogai(2019)	Synergy of ecosystems	Collaborative environment, mechanism, willingness, and ability are critical to ecosystem evolution
Lv Xueqing(2016) Zhang Weinian(2019)	The evolution of ecosystems	Dilemmas facing ecosystem evolution
Xiong Li(2020) Li Qiuzheng(2020)	Governance of ecosystems	The system design should meet the development needs of cross-border e-commerce, and the customs clearance supervision mechanism should be innovated.

2.2 Research on Evolutionary Dynamic Mechanisms in Cross-border E-commerce Ecosystems

Some domestic scholars have begun exploring the evolutionary dynamic mechanisms in cross-border e-commerce ecosystems, which represents a deeper level of thought in

this area. The discussion of dynamic mechanisms is a search for the essence of ecosystem evolution, and is marked by the unique developmental characteristics within this field. Wu Jiancai and others utilized the theories of synergy and super-circulation to propose that the evolution of commercial ecosystem dynamics depends on the competition and collaboration between various sub-systems within the ecosystem. As each member engages in activities of competition and collaboration, a sequencing parameter is produced that influences ecosystem evolution, accelerating the collaborative evolution process among members and the ecosystem as a whole (Wu et al., 2017). Li Junbo and colleagues used network analysis to construct a key development dynamic model for cross-border e-commerce ecosystems. Specifically, they analyzed the development dynamics of cross-border e-commerce ecosystems from three dimensions: political and social cultural, economic, and technological environments (Li et al., 2019). According to Tang Hongtao and others, the intrinsic driving force of the evolution of the internet ecosystem lies in network externalities, which promote the core platform of the ecosystem and aim to achieve iteration and evolution through increasing user numbers, improving user experience, and faster transaction efficiency. Market competition, policy changes, and user loss accelerate the segmentation of the traditional internet ecosystem, catalyzing the emergence of numerous independent ecosystems and becoming the external driving force for the evolution of the internet ecosystem (Tang et al., 2019). Based on the viewpoint of system dynamics, Xue Chaogai and others identified the key factors that influence the evolution of cross-border e-commerce ecosystems, and used system dynamics modeling to simulate the interactions between these factors, highlighting that policy support, technological level, and enterprise internal factors are crucial driving forces for the evolution of cross-border e-commerce ecosystems (Xue et al., 2020). Ning Lianju and colleagues explored the driving forces behind the emergence and evolution of commercial ecosystems from the perspective of transaction costs. They identified that an increase in internal transaction costs within the industrial chain is conducive to the formation of commercial ecosystems, while external transaction costs and dynamic external environments are the driving forces for the transformation of industrial chains into commercial ecosystems (Ning et al., 2020).

With the maturation and proliferation of internet and IoT technology, the formation of technologies such as cloud computing, edge computing, and fog computing, and the deepening of service-oriented enterprises' perception of real business scenarios, enterprise service ecosystems have attracted extensive attention from industry and academia. Chen Zhaojie and others evaluated the development of service ecosystems through the construction of an entropy model, pointing out that service and participation by members are the driving forces for the evolution of service ecosystems (Chen et al., 2020). However, due to the late introduction of the concept of cross-border e-commerce ecosystems, there is a significant lack of research on the interactive relationships between the factors that impact cross-border e-commerce ecosystem evolution and the driving mechanisms of this evolution.

Therefore, this paper will review the existing literature on the evolutionary dynamics of commercial ecosystems, platform ecosystems, service ecosystems, and other related fields, enriching research perspectives and providing empirical references for the study of cross-border e-commerce ecosystems.

The innovation of this article lies in its novel research objects, perspectives, and methods. Existing literature largely discusses the factors influencing the evolution of cross-border e-commerce ecosystems as the driving mechanisms of this evolution, while this article provides a clear definition of the driving mechanisms of the evolution of cross-border e-commerce ecosystems, emphasizing that these mechanisms result from the interactions among the ecosystem's internal members. In addition, this article employs normative analysis to summarize the driving mechanisms of the evolution of cross-border e-commerce ecosystems, and uses practical examples from Alibaba's practices to provide theoretical and practical evidence for its main points, resulting in a more rigorous conclusion.

2.3 Theoretical basis

2.3.1 The self-organization theory

The theory of self-organization was proposed in the 19th century, and the theory of phase transitions is a physical self-organization theory that explains the process of transitioning between gaseous, solid, and liquid states. The 1960s marked the peak of research on the theory of self-organization, with notable figures including Prigogine (1969) with his dissipative structures theory, Hermann (1976) with his theory of synergy, and Eigen (1971) with his theory of hypercycles. The theory of self-organization explains how constituent parts form groups through interactions, and through exchanging energy with the environment, complex organizations evolve into complex systems, providing new perspectives for scientists examining the natural world and human societies. Cross-border e-commerce ecosystems with cross-border e-commerce platforms at their core exhibit typical self-organizing features. In the early stages of platform construction, due to restrictions on the number of participating buyers and sellers, the platform is weak, and user experiences need to improve. However, with the increase in buyer users and the accumulation of data, the platform completes its first iterative upgrade. Simultaneously, attracting a large number of sellers to join, the platform gathers more members, and the embryonic form of the ecosystem emerges. While members continue to expand, interactions within the ecosystem persist, with energy in the form of commercial flow, logistics, and funds flowing around the platform, leading to the manifestation of self-growth effects. The addition of new members and changes in the competitive environment eliminate those companies that cannot adapt, leading to the platform's self-creation and self-annihilation processes. Therefore, the theory of self-organization runs through the entire process of growth and evolution of cross-border e-commerce

ecosystems, providing a framework for exploring the driving forces behind this evolution.

2.3.2 Transaction cost theory

In 1937, Coase introduced the concept of transaction costs in his article "The Nature of the Firm" (Coase, 1937). Williamson systematically studied the theory of transaction costs and pointed out that enterprises and markets are two interchangeable mechanisms for allocating resources. Due to limited rationality, opportunism, uncertainty, and small number conditions, market transaction costs can be high.To save transaction costs, enterprises emerged as a new form of transaction to replace the market. The existence of transaction costs determines the existence of enterprises, and the ultimate goal of adopting different organizational forms is also to save transaction costs. Williamson divided transaction costs into search costs, information costs, bargaining costs, decision costs, monitoring costs, and default costs (Williamson, 1975).

Considering the entire process of cross-border e-commerce transactions within an ecosystem, this study believes that transaction costs (or expenses) are concentrated in five aspects: information costs, logistics costs, payment costs, clearance costs, and after-sales costs. To achieve cost optimization and reduction in each aspect and every link, the integration of resources among all participants and coordination of each link are necessary. Therefore, from the perspective of reducing transaction costs to enhance transaction efficiency and profitability, the growth of the cross-border e-commerce ecosystem is aimed at reducing the credit costs and transaction costs of each link. From another perspective, the cooperation among members of each link to reduce transaction costs can also be seen as the driving force for the evolution and growth of the cross-border e-commerce ecosystem.

2.3.3 Industrial chain theory

The idea of the industrial chain was first proposed by Smith in the 18th century, who elaborated on the division of labor in industrial production in "The Wealth of Nations", which is considered the earliest bud of the industrial chain theory. In 1985, Porter put forward the concept of the value chain, which holds that the activities of design, production, sales, and delivery in enterprises can be represented by a value chain. With the introduction of concepts such as the supply chain, value chain, and enterprise chain, the connotation of the industrial chain has become more enriched. However, the industrial chain is also distinguished from these concepts. Rui Mingjie proposed the concept of a networked industrial chain (Rui, 2009), which gradually evolved into a new organizational form for the industrial chain. Combining the views of different scholars and the development process of the industrial chain theory, this study believes that an industrial chain refers to a gathering process of logistics, information

flow, capital flow, value flow ,and resource allocation, which occurs at specific time and space through the interrelated and decentralized upstream and downstream industries or representative enterprises. With the continuous refinement of the division of labor, it presents a network structure.

Cross-border e-commerce is a highly specialized form of the industry chain, separating the complex production process from the supply chain of goods itself. Throughout the process of cross-border e-commerce transactions from the seller to the buyer, there are numerous links involving many participating enterprises, changes in the value of goods, and the transfer of space. Along with this are the transmission and aggregation of value chains such as commercial flow, logistics, information flow ,and capital flow. The cross-border e-commerce ecosystem is formed based on the industrial chain formed by the participants with diverse functions in each link. Therefore, it is possible to explore the dynamic mechanisms of collaboration among members and the evolution of cross-border e-commerce ecosystems from the perspective of the industrial chain.

2.3.4 Symbiosis theory

The term "symbiosis" originated from the field of biology and was first proposed by German mycologist De Barry. The symbiotic theory of ecosystems argues that the interactions and interdependence between different species are key factors in maintaining the balance of an ecosystem. In the context of cross-border e-commerce, symbiosis refers to the relationship of mutual cooperation and interdependence between different businesses, organizations, and individuals, to achieve maximum profit and promote the healthy development of the entire cross-border e-commerce ecosystem.

There are many symbiotic relationships among the various participants in the cross-border e-commerce ecosystem, such as the cooperation between suppliers and e-commerce platforms, the shopping and payment relationship between e-commerce platforms and consumers, as well as the delivery relationship between logistics companies and e-commerce platforms. These symbiotic relationships can promote the transaction and transportation of goods, while also bringing commercial opportunities and economic benefits to the participants.

Transaction cost theory and industrial chain theory mainly provide theoretical support for the later induction of evolutionary dynamic mechanisms. Self-organization and symbiotic theories mainly explain the interaction and coordination among members of an ecosystem, highlighting the dynamic evolution process of the ecosystem. These theories ultimately provide a theoretical basis for the case study in this article.

3 Dynamic mechanism model of cross-border e-commerce ecosystem evolution

This chapter will analyze and elaborate on the driving forces and mechanisms for the evolution of cross-border e-commerce ecosystems. The process is illustrated in Figure

3.1 Cross-border e-commerce dynamic mechanism of ecosystem evolution analysis

(1) Mechanism of rules

Initially, trading rules were formulated by the leaders of the cross-border e-commerce ecosystem. As trading scenarios change, the frequency of transactions increases, and more members join, the rules evolve into a mechanism that regulates the trading behavior of ecosystem members. Cross-border e-commerce platforms occupy a dominant position in the cross-border e-commerce ecosystem and serve as the foundation for members to conduct transactions. To ensure the long-term operation of the platform and maintain the interests of all participants, cross-border e-commerce platforms must establish strict trading rules at the outset. In addition, there must be clear trading rules between cross-border e-commerce members, such as between suppliers and logistics providers or financial service providers and consumers. This is a dynamic interactive process, and as members' cooperation deepens, trading methods change, and policies change, trading rules also change, gradually forming a trading rule mechanism that meets trading needs.

(2) Mechanism of contracts

The mechanism of contracts emphasizes that members should establish written and unwritten contracts with each other to avoid their partners' default behaviors, build stable relationships, and reduce trading risks. The mechanism of contracts constrains member behaviors through internalized member relationships. The viewpoint of fully informative dynamic game theory in evolutionary economics shows that the members forming cooperative relationships establish a trust mechanism in repeated cooperation and interaction relationships. This relationship is embodied in the long-term contract mechanism among members in the cross-border e-commerce ecosystem. The contract mechanism reduces the negotiation and bargaining process for ecosystem members, reduces transaction uncertainty, and thus reduces transaction costs. Secondly, contract relationships promote stable operating environments and partner relationships, improve the ecosystem's risk resistance ability, and thus reduce trading costs generated by external environmental changes. Under the contract mechanism, when the operating situation of a certain member of the supply chain changes, other members can take timely feedback and adjust their operating strategies. At the same time, when the supply chain faces severe shocks or fierce competition, the contract mechanism can bring members together in a concerted response, maintain internal stability of the ecosystem, and improve the overall competitive level.

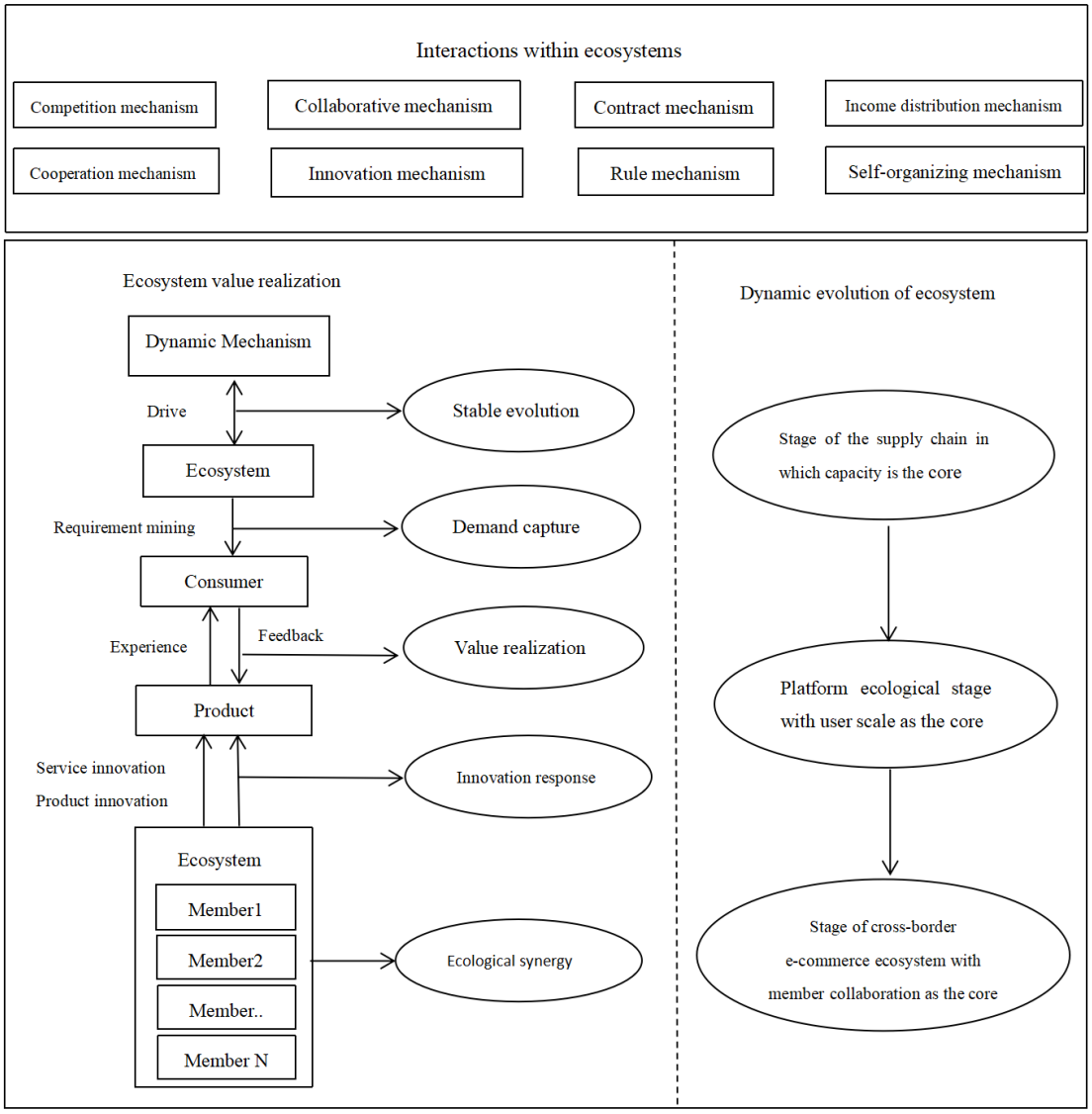

Fig1 Function diagram of the dynamic mechanism of ecosystem evolution

(3) Self-organization Mechanism

Self-organization mechanism emphasizes the ability of the ecosystem or organization to adjust based on changes in the external environment in order to improve its adaptability. Consumer demand is uncertain and data is dispersed across various channels, touch points, and scenarios, leading to behavior, transaction, and spatial data with different attributes. It is difficult for big data service providers to construct a single "full sample" database for individual consumers. Therefore, in the cross-border e-commerce ecosystem, logistics service, consumer credit service, and big data service providers can discover consumer needs and jointly develop consumer financial products based on shared consumer data to meet the changing needs of consumers over time. The service system should also be continuously iterated to ensure that the support and services consumers receive with each subsequent purchase are more comprehensive and attentive than the previous. In summary, the

information-sharing enables ecosystem members to grasp consumer demand changes as accurately as possible. The self-organization mechanism then innovates technology, services, and products based on information sharing to better meet consumer demand changes.

(4)Collaborative Mechanism

Collaborative evolution refers to the mutual influence and adaptation of different elements in the ecosystem over time. This means that changes in one aspect of the ecosystem, such as technology or regulations, may have a cascading effect on other elements such as consumer behavior or business practices. The dynamic interaction between different elements in the ecosystem determines how it functions and evolves.

Collaboration among members in the cross-border e-commerce ecosystem is the main path to achieve innovation, maintain ecosystem stability, and increase the overall benefits of participating members. Supply chain management is the most discussed topic regarding collaborative mechanism in the field of management science. Members' collaboration can achieve the growth of the entire supply chain and increase the benefits of supply chain members, which is a widely accepted management concept. From a management perspective, the supply chain itself is a broad value chain. The core issue of supply chain management is how to coordinate the behavior and decision-making of enterprises at various nodes in the supply chain to maximize the overall value of the supply chain and improve the level of benefits of participating members. (Shen, 2010). As the cross-border e-commerce ecosystem already contains numerous supply chains, the collaboration among ecosystem members can be seen as the deepening of supply chain collaboration, which involves not only collaborative production but also emphasizes collaborative demand forecasting (Dong, 2010), collaborative innovation (Ning, 2019), collaborative decision-making (Xue, 2017), (Cai, 2018), and information collaboration. Practice shows that members in the cross-border e-commerce ecosystem gradually evolve from a decentralized decision-making supply chain to a collaborative decision-making supply chain through long-term cooperation and interaction. The important components of the transaction process such as logistics, payment, overseas warehouse, distribution, and information transmission can create value for the supply chain through collaboration.

(5) Profit distribution mechanism

The profit distribution mechanism is widely used for the distribution of supply chain collaborative benefits and the determination of optimal equilibriums under game scenarios. By designing profit distribution plans and inserting profit distribution wedges, participating members can share collaborative benefits. Profit-sharing contract mechanisms can significantly increase the transfer of knowledge in supply chain collaborative innovation, which is beneficial to improving the overall profits of the supply chain, and can also help reduce the retail and wholesale prices of products. Moreover, the profit-sharing contract mechanism under bargaining conditions is more effective than the ordinary profit-sharing contract mechanism (Han, 2020). Profit-sharing contracts can effectively coordinate the supply chain after members

jointly invest in RFED technology, and this coordination idea enriches and expands the coordinated research on investment in RFID technology in the supply chain (Zhang, 2015).

Empirical studies on profit-sharing mechanisms in manufacturing supply chains, e-commerce supply chains, and e-commerce ecosystems have demonstrated that by establishing reasonable profit distribution mechanisms, the competitiveness of the ecosystem can be maintained, and the close cooperation among supply chain members can be further strengthened.

(6) Competition Mechanism

The cross-border e-commerce market is highly competitive, and the competition for market share and among enterprises has promoted the development and growth of the market. Companies improve the quality and efficiency of their products and services, lower costs, increase their competitive advantages, and obtain more market share through competition. For example, the competition between domestic e-commerce platforms such as Alibaba and JD.com has driven the development and growth of the e-commerce industry. The competition among various enterprises in the cross-border e-commerce ecosystem has also promoted the coordinated development and optimization of the entire system, such as the competition among logistics service providers that has driven the continuous improvement of the logistics network and the competition among payment service providers that has promoted the diversification of payment methods and the enhancement of security.

(7) Innovation Mechanism

Innovation refers to creating new opportunities and solutions to promote the development of the cross-border e-commerce ecosystem. In the cross-border e-commerce ecosystem, enterprises continuously introduce new products, services, and business models to promote the development of cross-border e-commerce. For example, Alibaba's innovation in launching the "Double Eleven" shopping festival has stimulated consumers' buying enthusiasm and promoted the development of global cross-border e-commerce. With the development of globalization and cultural diversity, consumer demands for quality, safety, speed, service, and other aspects continue to increase. The cross-border e-commerce ecosystem develops through a combination of adaptation and innovation. Participants in the ecosystem adjust their strategies and operations to adapt to constantly changing market conditions and regulatory frameworks. For example, e-commerce platforms may expand their product supply or enter new markets to capture emerging demands, while logistics providers may invest in new technologies or establish partnerships to improve service quality and efficiency. Innovation also promotes the development of the cross-border e-commerce ecosystem by creating new opportunities and disrupting existing structures. For example, the emergence of blockchain technology may change the way cross-border payments are made and verified, while the rise of social commerce is blurring the boundaries between e-commerce and social media.

(8) Cooperation Mechanism

Collaboration mechanisms among companies operating in the cross-border e-commerce ecosystem, such as strategic alliances, joint ventures, and platform ecosystems, are essential for the symbiosis of the cross-border e-commerce ecosystem. The symbiosis of the ecosystem is a complex system that requires mutual cooperation and co-development among all participants. Only by forming a good cooperative relationship among all parties can a win-win situation be achieved. The symbiosis of the cross-border e-commerce ecosystem also relies on the support of technology and digital technology, such as logistics technology, payment technology, big data analysis technology, etc. These technologies can improve the efficiency and reliability of the ecosystem, while also providing more business opportunities and development space for all participants.

3.2Analysis of the Driving Mechanism and Power Relationship in the Evolution of Cross-border E-commerce Ecosystem

This chapter first clarifies the driving mechanisms of the evolution of the cross-border e-commerce ecosystem and the relationship between these mechanisms and the evolution of the ecosystem. Our research suggests that driving mechanisms generate power, which drives the evolution of the ecosystem. The driving mechanism of the evolution of the cross-border e-commerce ecosystem is an internal mechanism formed through the interaction of its members. The relationship between the driving mechanism and power of the evolution is illustrated in Figure 2.

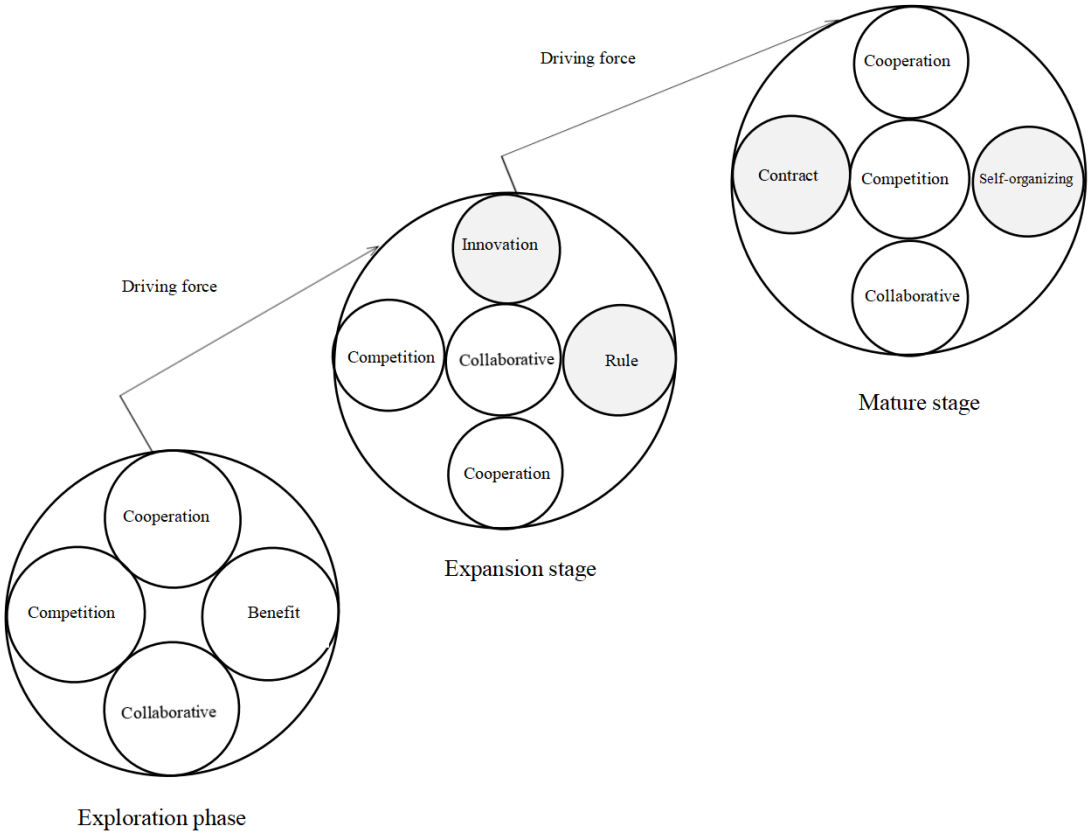

Fig2 Schematic diagram of dynamic mechanism and evolutionary dynamic relationship

This study believes that the driving mechanism for the evolution of cross-border e-commerce ecosystem will continue to be enriched as the ecosystem progresses from the exploration stage to the mature stage, with changes in the membership, capabilities, operating environment, and operating scale of the ecosystem. In the exploration stage of the cross-border e-commerce ecosystem, the core company, usually the cross-border e-commerce platform, leads the initial formation of the ecosystem by carrying out its construction and development, and the members of the system interact with each other in a symbiotic mode. To achieve long-term development, cross-border e-commerce platforms attract users to settle in by building platforms and providing high-quality services; merchants can sell products and make profits by relying on the platform, and consumers can buy the products they need through the platform. To survive, e-commerce platforms attract users with subsidies or free strategies through the competition mechanism and promise to provide high value-added and high-quality services. All member entities in the cross-border e-commerce ecosystem are interdependent and competitive. Driven by the competition mechanism and the interest mechanism, and influenced by continuous changes in internal and external environments, the characteristics of species within the system are retained or eliminated to form evolution, moving towards a more complex and powerful structure.

The cross-border e-commerce platform rapidly completes the accumulation of basic users, transitioning from the exploration stage to the expansion stage. Due to the rapid expansion in the early stage, fake and poor-quality products mix with the platform, and disputes between buyers and sellers increase rapidly with the increase in transactions. At this point, the rules mechanism begins to regulate the behavior of platform members to ensure the long-term stable and healthy development of the ecosystem. The expansion of user and transaction scales puts higher demands on the service responsiveness and stability of cross-border e-commerce platforms, and platforms can only achieve iteration through technological innovation and service innovation. More aggregation of consumers and merchants generates more diversified demand, and the collaborative mechanism begins to play a role, spurring the emergence of more specialized service providers such as marketing platform institutions and customized service providers.

After experiencing rapid expansion, the cross-border e-commerce ecosystem enters the mature stage. The long-term integration allows members of the ecosystem to form interdependent cooperative relationships, and the contract mechanism makes the cooperation between members more stable and trusting. In order to achieve higher profits, members in the ecosystem will choose collaborative decision-making and information sharing under the collaborative mechanism. The large amount of transaction data accumulated in the early stage enables the platform to help members

collaborate and share information. In addition, to improve the adaptability of the ecosystem, internal members of the ecosystem can make adjustments according to external environmental changes under the self-organization mechanism. After discovering consumer demand and sharing consumer data, multiple service providers will collaborate to develop products to meet the changing demands of consumers over time, continuously iterating the service system and providing consumers with more perfect and attentive service experiences. Thus, the internal driving mechanism, in interaction with the external environment, promotes the evolution of the new system and the decline of the old system.

4 Case study on dynamic mechanism of cross-border E-commerce ecosystem evolution

This chapter constructs a theoretical model of the cross-border e-commerce ecosystem and elucidates the role of driving mechanisms in the construction process of the cross-border e-commerce ecosystem by analyzing the representative practices of cross-border e-commerce enterprises.

4.1 Case Selection

The selection of case studies for this research aims to reflect the completeness and process of the cross-border e-commerce ecosystem, while also considering the evolutionary dynamics involved. Moreover, the selected case study must have already established a relatively complete ecosystem. Considering completeness and process is key to fully assessing the underlying evolutionary dynamics. From the perspectives of the completeness of ecosystem construction, the duration of ecosystem evolution, and the scale of platform transactions, this research selects AliExpress as the case study. On the one hand, since its establishment in 2010, AliExpress has developed for more than a decade, building a relatively complete ecosystem with the support of resources provided by Alibaba Group, which comprises three crucial components: core e-commerce platforms, cross-border logistics, and payment platforms. On the other hand, AliExpress is the largest domestic B2C cross-border e-commerce platform in China. It has over 200 countries and regions where it operates and has millions of registered users abroad. Therefore, the AliExpress ecosystem is typical.

The main purpose of this research is to study the evolutionary dynamics of the cross-border e-commerce ecosystem. The effectiveness of the case study depends on the construction of theoretical models and detail excavation of typical cases based on solid data and field research, which reflects the complexity of research objectives and is able to answer the "why" and "how" questions. This research aims to analyze the practice of ecosystem construction on AliExpress to clarify the role of driving mechanisms involved and further demonstrate the objectivity of the theoretical model.

4.2 Data collection

This study obtained direct data through on-site interviews with key personnel of AliExpress. Furthermore, the growth of the AliExpress ecosystem cannot be separated from the support of Alibaba Group's capital, technical team, and management team. Indirect data related to the AliExpress development were obtained through channels such as Alibaba Research Institute, the Alibaba Group website, AliExpress website, Alibaba AliExpress WeChat official account, AliExpress University, and the AliExpress 10th Anniversary Summit. Rich industry materials were obtained from websites such as iResearch Consulting, Yibang Power Net, Netjing, and the China e-commerce Research Center, which provided information on industry background, cooperative relationships, practical processes, business models, strategic direction relevant to the AliExpress ecosystem practice, and effective reference materials for building AliExpress ecosystem. The specifics and sources are shown in tables 2 and 3.

Table2 Source of information on AliExpress ecosystem construction

Data content	Content	Data source
Industry background	External environment for the development of AliExpress	Aliresearch、Industry research report
Business background	Internal organizational structure and existing problems of AliExpress	Aliexpress website, enterprise news
Forms of cooperation	Main partners and cooperative relations of AliExpress	AliExpress Summit、Industry research report
Practice process	The establishment and operation of AliExpress	Aliexpress website、enterprise news
Business model	Development history and future development strategy of AliExpress	Aliresearch、Industry research report

Table3 Content of field research

Research object	Research content
Zhao Tianrui (AliExpress Export Division)	Enterprise supply chain evolution; Core advantages of the enterprise
Zhang Shan (AliExpress Operation Department)	Customer drainage; Market expansion; Localization strategy
Wang Qi (AliExpress Overseas User Department)	Logistics network; Operation management; Technology and innovation
Li Zhaohui (Supply Chain Division, AliExpress)	Ecological member;Enterprise supply chain evolution;Logistics network

4.3 Case analysis

4.3.1Analysis of AliExpress ecosystem construction

Affected by the global financial crisis, overseas buyer orders plummeted in 2008, causing a significant impact on Alibaba's overseas B2B business. However, Alibaba was quick to respond to the increasing number of overseas individual users and diverse product demands, which presented an opportunity for traditional B2B business to transition towards a more personalized service. In 2010, Alibaba incubated AliExpress, which specializes in small-scale wholesale and gradually expanded to offer services to individual overseas buyers. The first three years after its establishment marked the first stage of AliExpress's development, characterized by the transition from traditional B2B business to B2C business. From 2013 to 2016, AliExpress entered its second stage of development, where it fully transitioned to B2C business and developed corresponding strategies to expand the platform. AliExpress recruited high-quality brands to join the platform through strategies such as free entry, guidance, and subsidies. They also laid out a strategic focus on markets such as Russia and Spain, while increasing overseas strategic node investment to help build the logistics infrastructure and improve payment security. From 2017 to now, AliExpress has entered a period of business expansion, and its B2C business has matured, rapidly increasing its share of cross-border e-commerce transactions. To meet the demand volume and diversity of growing users, AliExpress leveraged Alibaba's technological system to empower merchants by implementing technologies such as the overseas version of “1,000 faces” for product selection and customer recognition. As of December 2022, AliExpress has opened 19 language versions, achieving full coverage of cross-border exports to all countries and regions along the Belt and Road Initiative. With over 150 million registered users overseas, it has formed an e-commerce ecosystem centered on AliExpress and its platforms, which is the result of the mutual interaction between internal members and external environments.

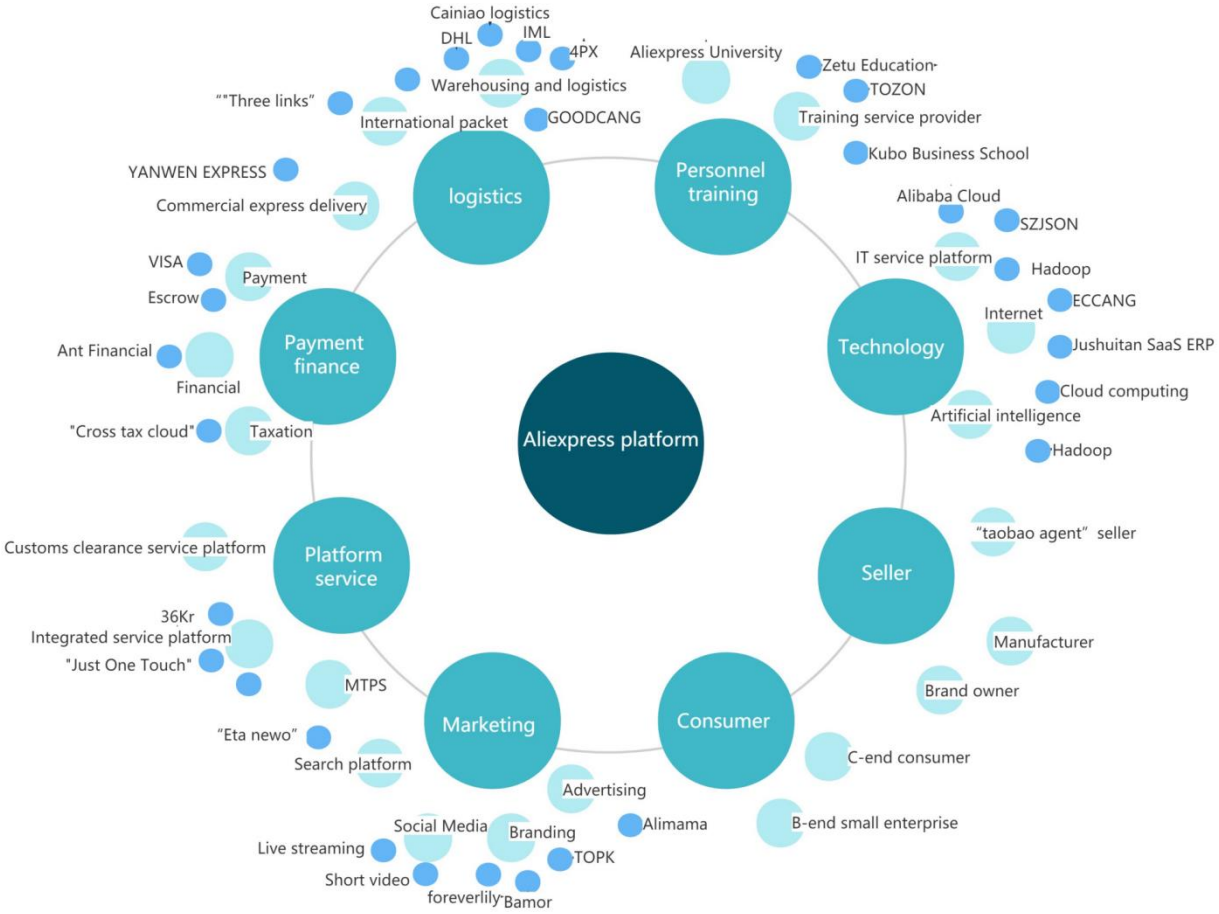

Fig3 Concept map of AliExpress ecosystem

4.3.2 Analysis on dynamic mechanism of AliExpress ecosystem evolution

As an open platform, the evolution of AliExpress is driven by the power mechanism formed by the long-term interaction between internal members. Based on the AliExpress Summit and relevant information disclosed on Alibaba's official website, we summarize the power mechanism of AliExpress's evolution.

(1) Rules mechanism. Trading rules are related to the interests of all participating members, specifically involving the admission rules of buyers and sellers, platform fee rules, dispute resolution mechanisms, regulatory punishment mechanisms, etc. Since 2013, Aliexpress has raised seller admission standards, allowing only businesses to enter the platform. On the one hand, this is an adjustment to the AliExpress strategic positioning, and on the other hand, it is due to the proliferation of fake and inferior products and infringement of intellectual property by AliExpress vendors. In 2016, to address the problem of a large number of fake goods on the website that infringe on the legitimate rights and interests of consumers, AliExpress took a series of measures to improve the user experience and resolve the credit crisis. On the one hand, Alibaba has introduced strict regulatory measures, including increasing intellectual property protection, conducting spot checks on goods sold on the platform, and forcing goods to be taken down when infringement or fake products occur. At the same time, a "credit penalty" system was implemented, and the "Global

AliExpress Platform Rules (Sellers)" was introduced. On the other hand, it uses technology to achieve real-time supervision, utilizing big data and artificial intelligence technology to introduce the "Intellectual Property Protection Brain," which detects seller pictures, chat messages, and shared links 24 hours a day, scanning 1 million transactions per second, with 96% of infringing links being detected and recognized at the moment of publication. In 2018 and 2019, the rules will continue to be strict, and there will be many changes in the rules every year or even every month, from the annual technical fee of 5000 in 15 years to the current 1W, from the Chinese trademark can be settled in to the current English trademark can be settled in. At present, some categories have stopped attracting investment and started to collect deposit, so the following changes will be greater. Traffic ends up favoring gold, or at least silver, sellers, and regular sellers have little chance.

Aliexpress gradually raises the threshold and pushes forward to the direction of branding and quality in the process of reshuffling.Timely adjustment of trading rules and a strong technical support system have improved the trading environment of AliExpress, resolved the platform's credit crisis, attracted brand merchants to join AliExpress, retained high-net-worth users, and provided a solid foundation for platform expansion. It has also reduced the credit costs of suppliers, buyers, sellers, and the platform, enabling the positive feedback loop of all participating parties.

(2) Innovation mechanism. During the early stages of the Internet industry, the innovative business model and innovative thinking of Alibaba were one of the important driving factors in the company's rapid growth. The emergence and application of new technologies can provide more convenient and efficient services for cross-border e-commerce, promoting the growth of the AliExpress market. For example, the emergence of new technologies such as mobile payments and blockchain, as well as the application of artificial intelligence and cloud computing, have promoted the development of AliExpress in areas such as payment and logistics and provided new impetus for AliExpress.

In the process of collecting information and making transaction decisions, AliExpress uses Alibaba's strong technological reserves to empower merchants by utilizing Alibaba's mature artificial intelligence and algorithm technology to analyze the accumulated massive user and transaction accumulation data. The most important thing is to open up user portrait data to merchants for marketing and new product decision-making. In addition, AliExpress has launched an intelligent product diagnosis system to predict different countries' transaction needs, helping merchants to select products, stock, design, produce and make intelligent recommendations according to the preferences of different users, striving to increase product exposure.

With the changes of consumer behavior and consumption habits, AliExpress is constantly adjusting its business model and services to meet the needs of consumers. For example, during the epidemic period, AliExpress met the consumers' demand for online shopping through new businesses such as live streaming sales, promoting the development of the business. Meanwhile, AliExpress also promotes the brand and products through content marketing, expanding brand influence and market share.

In summary, relying on the ecological evolution process of cross-border e-commerce of Alibaba, AliExpress continuously promotes the development of cross-border e-commerce business through innovation in digital upgrading, global supply chain system, socialization and content development.

(3) Collaborative mechanism. In order to gain a competitive advantage and break away from foreign cross-border e-commerce platforms with high visibility and reputation, AliExpress adopted a "one-by-one" approach. First of all, with the support of the supply chain resources accumulated by Alibaba's international B2B platform, AliExpress quickly integrated sellers by attracting them through "free + guidance + subsidies" in the early stages. Additionally, AliExpress opened up the "Taobao consignment" function, directly bringing Taobao merchants to the platform, which greatly enriched the variety of goods and activated the seller side, meeting market demand together. Furthermore, in the early days of AliExpress, it did not blindly expand but focused on targeted market development, with Russia, Spain, and Brazil as the focus markets. Through marketing strategies and practical services such as specialized logistics, overseas warehouses, and easy returns and exchanges, AliExpress not only raised market awareness but also improved user experience, establishing a positive image among its platform and seller communities.

After the 2016 credit crisis resulting from rapid expansion, AliExpress realized that branding was the future for the development of Chinese small and medium-sized enterprises. Pure ODM and OEM models cannot obtain bargaining power, and only through more brands establishing brand images can the image of AliExpress be changed, thereby gaining consumer trust. On the one hand, AliExpress increased recruitment efforts for Chinese brand merchants, encouraging them to join by increasing exposure, providing diamond booths, and buyer-direct exhibition facilities. Additionally, utilizing AliExpress's marketing and channel advantages, AliExpress launched the "Popeye Plan," providing targeted assistance to new brand merchants. From selecting products, various golden periods of operations are grasped with the official online education group recording attendance and answering questions, and the coach tracking progress. AliExpress initiated new merchant growth tasks, which officially updated the merchant backstage in May 2020. Additional measures were taken to support new brands such as showcasing goods, distributing coupons to new buyers, targeting selection through alliance programs, and labeling new products inside and outside the website with silver and green channels. On the other hand, through fan operations, guide media, social media, search platforms, and other means, AliExpress attracted enough online attention and traffic for merchants, aggressively exploring expansion paths in offline channels. By increasing exposure through platforms like Burger King, telecom shops, and shopping malls, platform incubation, retail channel establishment, and maximized contact with consumers and sales increased, leading to revenue growth and platform prosperity.

Through case analysis of the evolution of the AliExpress ecosystem, starting from platform construction to the continuous addition of members, the system has been

continuously refined and gradually developed. The driving mechanisms for the evolution of the AliExpress ecosystem can be summarized as contract mechanisms, regulatory mechanisms, collaborative mechanisms, profit-sharing mechanisms, information-sharing mechanisms, and self-organizing mechanisms. This article analyzes the rule mechanisms, information sharing mechanisms, and collaborative mechanisms in the process of constructing AliExpress.

4 Conclusion and Prospect

As information technology is widely applied and infrastructure continuously improved, cross-border e-commerce has prospered and presented a trend of ecological dominance by core platforms, attracting the attention of many scholars. Through reviewing relevant research achievements, it was found that scholars' exploration of the driving mechanisms of cross-border e-commerce ecological system evolution was still inadequate and had not formed a systematic viewpoint. Therefore, this study aims to summarize the general laws of the driving mechanisms of cross-border e-commerce ecological system evolution, taking them as the research object.

4.1 Research conclusion

The essence of analyzing the driving mechanism of cross-border e-commerce ecological system evolution is to explore the intrinsic mechanisms and operating mechanisms of cross-border e-commerce ecological evolution. The driving mechanism of cross-border e-commerce ecological system evolution is the internal relationships formed by close contacts and interactions among cross-border e-commerce participants, which are the laws of internal activities and environmental interactions in the ecological system of cross-border e-commerce. That is, the driving mechanism is the stable relationship that emerges among members as the cross-border e-commerce ecological system develops continuously. These relationships will produce new connotations with changes in the number of members, changes in member capabilities, changes in operating environments, and other factors. This paper summarizes the driving mechanisms of cross-border e-commerce ecological system evolution as: transaction rule mechanism, profit distribution mechanism, contract mechanism, self-organizing mechanism, information sharing mechanism, and collaborative decision-making mechanism, combining transaction cost theory and evolutionary economics perspectives. The practice of constructing an ecological system by AliExpress suggests that building an ecological system is an inevitable way for cross-border e-commerce platforms to expand their scale and withstand risks. In the process of building an ecological system, platform rules should be adjusted in a timely manner, and the platform iteration speed should be accelerated to encourage participating members to achieve synergy.

4.2 Research Prospects

The cross-border e-commerce ecological system is a dynamic and complex open system that has attracted the attention of many scholars. However, discussions on the driving mechanisms of cross-border e-commerce ecological system evolution have yet to yield systematic results, and there are differences in the selection of research theories and methods. Although this paper has reviewed previous literature, there are still deficiencies.

Firstly, the cross-border e-commerce ecological system itself is complex, and future research on the driving mechanisms of cross-border e-commerce ecological system evolution should consider more factors and dimensions. Secondly, this paper analyzed the driving mechanisms of cross-border e-commerce ecological system evolution using a case study method. In the future, empirical methods can be used to examine the driving mechanisms. Additionally, this paper focused on Alibaba's AliExpress platform as a single case study. In the future, multiple case studies can be used to compare and analyze the driving mechanisms, in order to modify theoretical models.

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