Industrial Organization in the Digital Economy Era: Evolution and Effects

Guo Chaoxian, Hui Wei*
Institute of Industrial Economics (IIE), Chinese Academy of Social Sciences (CASS), Beijing, China

Abstract: *Advances in digital technology and vast data applications have resulted in the emergence of the digital economy paradigm, which is a new techno-economic paradigm for the digital economy age. Under this paradigm, the industrial organization has shifted toward networked, platform-based, boundaryless, and integrated development with new characteristics. Specifically, there has been a fierce "positional arms race" fueled by financial capital, accelerating the growth of platform companies. The "hierarchical monopolistic competition" market structure has taken shape, resulting in a "coexistence without disruption" monopolistic competition. As platform businesses expand into new business sectors, competition among industrial ecosystems intensifies. Data and algorithms have become secret weapons for corporate success, allowing platform companies to expand their monopolistic forces. Industrial organization in the digital era has revolutionized the operating rules and logic of industrial economy, giving rise to new industries, business models, and paradigms, as well as being conducive to international cooperation and intelligent regulation. Meanwhile, it has introduced new challenges to socioeconomic development, making platform companies' anti-competitive and monopolistic behaviors more implicit, privacy and security concerns more conspicuous, and antitrust identification and investigation more difficult. The government should embrace the evolving trends of industrial organization in the digital economy era, accelerate regulatory transition, and strengthen governance and regulation under the digital economy paradigm.*

Keywords: *Digital economy, evolution of industrial organization, platform companies, governance and regulation*
JEL Classification Codes: L00
DOI: 10.19602/j.chinaeconomist.2024.07.02

1. Introduction

Industrial organization is an organic intra-industrial structure. It is a market-based relationship and organizational structure inside an industry and among businesses. Instead of a standard statistical notion, industry is a collection of businesses that provide closely substitutable goods or services in a specific market. The main question for the discipline of industrial organization is the monopolistic and competitive relationship between enterprises; the goal of research on this topic is to develop a market structure and market behaviors that promote effective competition and improve the order of the market economy for high-quality economic development. Since the Industrial Revolution, generations of economists have witnessed and studied the industrialization process in human civilization. Their

* CONTACT: Hui Wei, email: hw-618@outlook.com.
Acknowledgment: This study is supported by the National Social Science Fund of China (NSSFC) (Grant No. 21CJL027); Think-tank Project for Industrial and Regional Development of the Chinese Academy of Social Sciences (CASS) (Grant No. GJSZKB202312); Key Discipline of the Peak Strategy of CASS (Regional Economics) (Grant No. DF2023ZD24).

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theories and principles had a significant impact on economic development in numerous countries, and the discipline of industrial organization inspired several schools, including the Harvard School, the Chicago School, and the new theory of industrial organization. However, the new industrial economy theory that originated during the industrial period is not completely applicable to the digital economy era (Shi, 2022). According to the *14th Five-year Plan for the Digital Economy*[1], the digital economy has emerged as a new economic paradigm following the agricultural and industrial economies: Integrated ICT applications and total-factor digitalization drive fairness and efficiency improvements via the modern information network, with data resources serving as the critical factor of production. The digital economy has challenged many established economic assumptions. For example, agricultural and industrial economies face declining returns, whereas digital products do not (Pei et al., 2018). Digital innovations have given rise to the platform economy. Compared to the traditional economy, the platform economy is distinguished by two-sided interactions, multi-attributes, externalities, service orientation, and the coexistence of competition and monopoly. The associated business model innovation and platform business model have resulted in a limitless supply of Internet-based goods and services at no cost, which is unthinkable in the traditional economy (Li et al., 2013).

The digital economy has impacted industrial organization in a variety of ways. One significant shift is that the homogeneous linear upstream and downstream supply chain relations of the industrial economy era have given way to a meshwork of supply chains between various vendors in the digital economy (Shi, 2022). The changing nature of industrial organization has also altered antitrust rules. Traditional antitrust regulations are based on the industrial organization theory, which has its roots in the general equilibrium theory. In the industrial economy era, when the production and consumption functions are generally stable, the goal is to maximize resource allocation efficiency; in the digital economy era, technology innovation causes changes in the production and consumption functions, challenging traditional antitrust rules in regulating the digital economy (Pei et al., 2018). As a result, it is significant for the academia to expound on the evolving trends, characteristics, and implications of industrial organization in the digital economy era, as well as to investigate strategies to capitalize on opportunities and address challenges, and to strengthen governance and regulation under the digital economy paradigm.

This paper stands out from existing research in three distinct ways. Firstly, it delves into the underlying factors that drive the evolution of industrial organization in the digital economy era, focusing on the shift in paradigms. Secondly, it provides a comprehensive review of the emerging trends and unique characteristics in the evolution of industrial organization during this era. Lastly, it analyzes the implications of these changes, along with the opportunities and challenges they bring.

2. Analytical Framework

Science and technology play a crucial role in driving social transformations. In the age of the digital economy, the techno-economic paradigm of our society has undergone a fundamental transformation due to breakthrough advancements in various information and digital technologies. These include the Internet, big data, artificial intelligence (AI), mobile Internet, cloud computing, and the Internet of things (IoT). Such a techno-economic paradigm means breakthrough advancements in generic technologies are followed by a massive emergence, rapid industrialization and commercialization, and widespread adoption of interconnected technology clusters across various industries, leading to transformations in productivity, organization, and business models, as well as in the overall social and institutional framework (Perez, 2007). This represents a shift in the techno-economic landscape. In contrast to the era

[1] Source: *Notice of the State Council on the Issuance of the Plan for Development of the Digital Economy during the "14th Five-Year Plan" Period,* https://www.gov.cn/zhengce/zhengceku/2022-01/12/content_5667817.htm.

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of industrial economy, the digital economy era has brought about a completely new techno-economic paradigm. There has been some research literature that has brought up the topic of a significant shift in the way technology and the economy interact. As an example, Liang and Li (2020) argue that the close integration of modern information technology and advanced manufacturing technology in the digital economy era has resulted in a new manufacturing approach characterized by precision, flexibility, and agility. This has given rise to a platform-based industrial innovation ecosystem, which represents a new form of industrial organization. Some studies have described the techno-economic paradigm in the digital economy as the digital economy paradigm. According to Wang and Chen (2019), the digital economy emerged in the 1980s and 1990s and matured after the burst of the Internet bubble in 2000. In the 2020s, advanced information technologies such as big data, AI, mobile Internet, cloud computing, and IoT have driven the rapid growth of the digital economy at a higher technological level. This digital economic paradigm is expected to remain dominant for the next three decades. Beyond that, the integration of ICTs and biotechnology may give rise to a "biotechnology paradigm". Li and Liu (2022) investigated changes in the innovation paradigm in the digital economy. They argue that the innovation paradigm of digital economy via cyberspace includes four aspects, i.e., spatial-temporality, interactivity, openness, and cross-sectoral development. In contrast to the industrial economy, the digital economy has a unique innovation paradigm that emphasizes diversity, network, and ecosystem.

Technological change catalyzes shifts in the techno-economic paradigm, which are followed by transformations in dominant technologies, modes of productive organization, business models, institutional frameworks, and best practices (Wang and Chen, 2019). As the digital economy paradigm emerges within a fresh cycle of techno-economic paradigm shift, change in industrial organization is unavoidable due to the following two reasons. First, new digital technologies provide the primary drive for the digitization of industrial organization. One of the most significant changes to human society brought about by digital technology is the development of cyberspace as a whole new world, opening up a new dimension of value creation and market competition. The Internet, big data, cloud computing, mobile Internet, the IoT, AI, 4G or 5G communications, and digital technologies may fundamentally alter the rules, logic and form of industrial organization with the techno-economic attributes of substitutability, permeability and coordination (Cai, 2018). Second, the new data factor serves as the foundation for the digital transformation of industrial organization. Data resources are referred to as the "oil of the 21st century" in the digital economy era, and data has been incorporated into the production function as a new economic growth factor to restructure the system of production factors and broaden the boundary of the traditional economic growth theory. The data factor is not subject to scarcity and exclusivity as are the traditional factors of production because of its non-exclusivity, non-competition, fast transmission, and reproducibility characteristics. The data-enabled transformation of the input-output relationship may give socioeconomic development new impetus and greatly increase economic quality and efficiency (Zhang and Wang, 2023). On March 30, 2020, the CPC Central Committee and the State Council announced the *Opinions on Improving the Market-based Factor Allocation System*[2], which designated data as one of the five factors of production alongside labor, capital, technology, and land. This demonstrates the Chinese government's understanding of the criticality of data in developing the digital economy.

In this research, we present an analytical framework for the evolution of industrial organization in the digital economy era, as well as its ramifications, as shown in Figure 1. First, digital technology and the data factor have created a new paradigm for the digital economy, changing industrial organization into networked, platform-based, boundaryless, and integrated development. Second, the digital economy

[2] Source: *Opinions of the CPC Central Committee and the State Council on Improving the Market-based Factor Allocation System*, https://www.gov.cn/zhengce/2020-04/09/content_5500622.htm.

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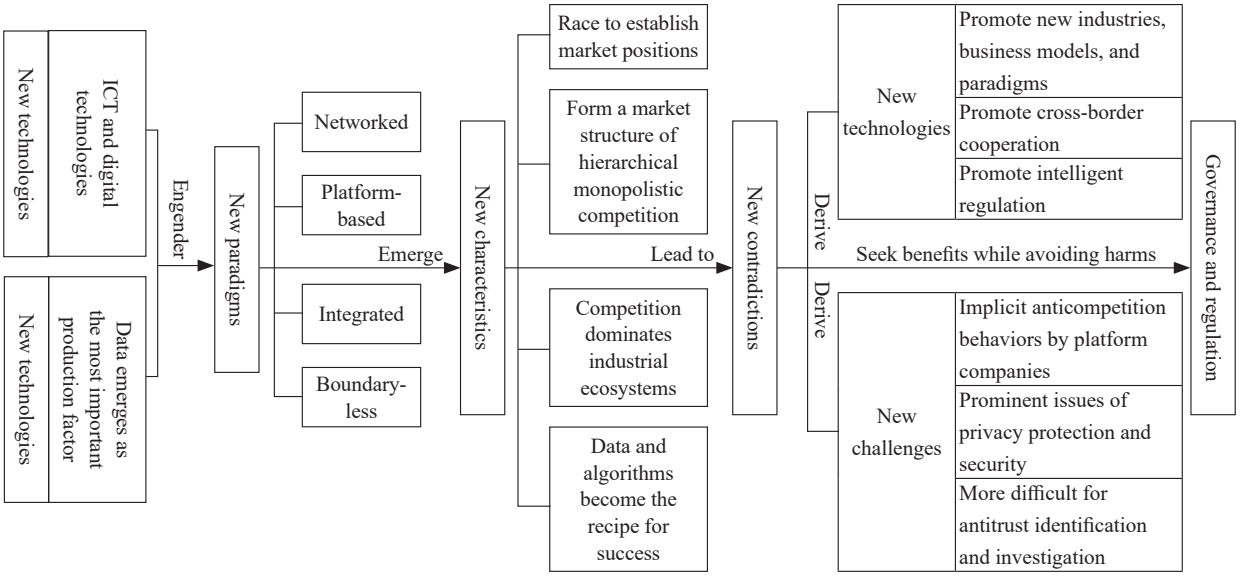

Figure 1: Analytical Framework for the Evolution of Industrial Organization in the Digital Economy Era and Its Effects

paradigm has brought about certain new characteristics to industrial organization. Third, new paradigms and features invariably result in unprecedented contradictions, which drive the growth of industrial organization while presenting opportunities, risks, and problems. Finally, we must strengthen governance and regulation in the digital economy paradigm to maximize advantages while minimizing downsides.

3. Basic Trends of Evolving Industrial Organization

The digital economy is booming, thanks to the rapid development of ICTs and digital technologies, as well as an ocean of data that serves as a production factor in economic operations. The interaction between industry and digitalization has resulted in the emergence of new industries, business models, and paradigms, as well as the continual evolution of industrial organization towards networked, platform-based, boundaryless, and integrated development.

3.1 Networked

Networks are a relationship of production and cooperation between firms. New resources, production factors, and demand have been reorganized in a networked fashion driven by digital technology, the data production factor, and social demand, as opposed to the old type of industrial organization, particularly vertically integrated organization. The network-based industrial organization is a new type of industrial organization that combines social production and corporate organization. It has emerged as a result of technological advancements in current information and digital technologies, as well as the emergence of business models in e-commerce and supply chains. According to Schumpeter (Li, 2005), this process of vertical fragmentation and network-based integration reflects “creative destruction” of innovation. This allows resources to be used more efficiently, new value to be created, and for businesses to cut costs, boost efficiency, and widen their development opportunities.

In the era of the digital economy, advancements in technology have transformed our social life into a connected network. This has given rise to a new way of organizing industries based on networks. The integration of communication, computer, and control technologies has led to the development of cyber-physical systems (CPS). These systems allow for real-time sensing, dynamic control, and information services for large engineering systems in industrial control networks. Network technologies like the

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Internet, the IoT, 5G communication, and CPS not only foster the growth of new industries but also reshape the existing industrial landscape. This leads to fundamental changes in industrial structure, organization, interconnection, and layout. While network operations bring about positive network effects, they also give rise to new challenges such as online platform monopolies, network neutrality, information security, and privacy protection.

The Metcalfe Law[3], created by Robert Metcalfe, the pioneer of the ethernet standard, has greatly enhanced our comprehension of the significance of networks. This law states that the value of a network is directly linked to the square of the number of connected users (N^2). However, Reed has proposed a new idea that suggests the value of networks grows exponentially as more people join (2^N), surpassing the rate described in Metcalfe's law. The value of a network increases as more consumers and compatible products join, creating what is known as the network effect or network externalities. The network effect describes how the value of a product or service increases as more people use it. This is because each additional user adds to the overall demand and makes the product more valuable for everyone. When individuals are able to connect to a larger network, they can experience greater value compared to connecting to a smaller network. There are different types of network effects, including direct and indirect network effects. The direct network effect describes how a consumer network directly affects the value of a product. On the other hand, the indirect network effect, also called the cross-network effect, occurs when increased usage of a particular product leads to increased consumption of complementary goods (Zhang, 2023).

3.2 Platform-based

The rise of online platform entities has led traditional enterprises to embrace digital transitions, with platforms becoming the fundamental form of economic organization for resource coordination, value creation, and aggregation. In the platform economy, there is a unique relationship between platform companies and users. Unlike in the traditional economy, this relationship is characterized by a close association and mutual dependence in a two-sided market. Platforms enabled by digital and Internet technologies are a new form of organization that brings an upgrade to traditional industrial organization and revolutionizes the traditional economic paradigm. In a two-sided market, the positive cross-network externalities result in increased value for users on the other side when there are more users on the platform side and more frequent use of the platform. Given the preference of users for dominant platforms that have a large user base, the network effect will pose a significant challenge for new players trying to enter the market.

Digital platforms often have a combination of direct and indirect network effects, creating a positive feedback loop that leads to a highly centralized market structure where a single player dominates. The rise of the digital economy has resulted in a remarkable expansion of the platform economy. By the end of 2020, there were 76 digital platform companies worldwide that boasted a market capitalization exceeding 10 billion US dollars. These companies collectively held a staggering market capitalization of 12.5 trillion US dollars, marking a 57% increase compared to the previous year (CAICT, 2021). By the conclusion of 2020, China witnessed a surge in the number of digital platform companies, with 197 entities each boasting a market capitalization exceeding 10 billion US dollars, which is an increase of 133 entities from 2015. This signifies an impressive annual growth rate of over 26 companies. In recent years, there has been a significant rise in the value of various platform companies. Among them, there are 36 companies that each has a market capitalization exceeding 10 billion US dollars; among them are the most prominent platforms such as Alibaba, Tencent, ByteDance, Meituan, and Pinduoduo, each

[3] Source: The Network Effects Manual: 16 Network Effects (And Counting), https://www.nfx.com/post/network-effects-manual.

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valued at over 100 billion US dollars (Policy and Economic Research Institute of CAICT, 2021).

Table 1 lists the ten most valuable firms in the world. In the top ten, a trend is platform companies increase fast and account for a rising share of market capitalization. In 2010, Apple and Microsoft stood out as the sole digital platform companies in the top ten most valuable companies, collectively representing 21.92% of the total market capitalization. This number rose to five, capturing 59.06% in 2015, and then climbed to seven, reaching a share of 77.84% in 2018, before hitting its highest point at eight, with a share of 79.55% in 2020. At first glance, there has been a significant decrease in the number of platform companies and their market capitalization in the past couple of years (in 2022 and 2023). It

Table 1: Ten Most Valuable Global Companies by Market Cap

Ranking	2010		2015		2018	
	Name of company	Market cap (100 million US dollars)	Name of company	Market cap (100 million US dollars)	Name of company	Market cap (100 million US dollars)
1	Exxon Mobil	3,641	Apple	5,836	Microsoft	7,804
2	China National Petroleum Corporation	3,019	Google	5,282	Apple	7,461
3	Apple	2,959	Microsoft	4,397	Amazon	7,375
4	Microsoft	2,388	Berkshire	3,253	Google	7,236
5	Industrial & Commercial Bank of China	2,325	Exxon Mobil	3,240	Berkshire	5,024
6	China Construction Bank	2,220	Amazon	3,183	Tencent Holdings	3,816
7	China Mobile	1,990	Facebook	2,978	Facebook	3,741
8	Berkshire	1,983	General Electric	2,922	Alibaba	3,525
9	General Electric	1,942	Johnson & Johnson	2,842	Johnson & Johnson	3,436
10	Walmart	1,921	Wells Fargo	2,768	J.P. Morgan Chase	3,198
Number of Internet capital companies	2		5		7	
Share of Internet platform companies (%)	21.92		59.06		77.84	
Ranking	2020		2022		2023	
	Company name	Market cap (100 million US dollars)	Company name	Market cap (100 million US dollars)	Company name	Market cap (100 million US dollars)
1	Apple	22,323	Apple	20,669	Apple	30,509
2	Saudi Aramco	18,656	Microsoft	17,877	Microsoft	25,321
3	Microsoft	16,784	Saudi Aramco	17,081	Saudi Aramco	17,194
4	Amazon	16,382	Google	11,450	Google	15,274
5	Google	11,832	Amazon	8,569	Amazon	13,375
6	Unilever	10,316	Berkshire	6,806	Nvidia	10,449
7	Facebook	7,782	United Health Group	4,954	Tesla	8,297

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Table 1 Continued

Ranking	2020		2022		2023	
	Company name	Market cap (100 million US dollars)	Company name	Market cap (100 million US dollars)	Company name	Market cap (100 million US dollars)
8	Tencent Holdings	6,980	Johnson & Johnson	4,618	Berkshire	7,469
9	Tesla	6,774	Exxon Mobil	4,542	Facebook	7,355
10	Alibaba	6,507	Tencent Holdings	4,099	TSMC	5,234
Number of Internet platform companies	8		5		5	
Market cap of Internet platform companies (%)	79.55		62.25		65.37	

Notes: (i) Market capitalization represents the fair market value of equity of listed companies. When a company is listed on multiple markets, its market capitalization is determined by combining the prices and quantities of various types of shares. (ii) This market capitalization is then converted into the present-day value in US dollars. (iii) The valuation for 2023 depends on the share price on the last closing day in June, while valuations for other years are based on the share price on the final closing day of the year.
Source: Compiled based on Wind database (https://www.wind.com.cn).

is worth mentioning, however, that certain recently emerged leading companies like Nvidia, Tesla, and TSMC are expediting their shift towards platform operations. They are achieving this by integrating their manufacturing and service ecosystems, transforming themselves from hardware manufacturers into platform operators. The significance of platform companies is set to further increase.

3.3 Boundaryless

The digital economy has given rise to digital platforms such as Apple, Google, Microsoft, Amazon, Facebook, Tencent, and Alibaba, which have become the basic kind of organization that supports the digital economy. In theory, the digital platform organization originated basically from traditional hierarchical organization and market organization. Instead of a mere combination of the two, the digital platform organization constitutes an entirely new organizational paradigm. From a division of labor standpoint, new organizations emerge from new divisions of work and collaboration, whereas the digital platform organization emerged from a deepening division of labor facilitated by digital technology. Hierarchical organization refers to an assigned division of labor based on asset ownership and employment relationships. The market organization involves the division of labor among autonomous entities based on a contractual relationship. In contrast, the digital platform organization is a completely new type of organization based on the assigned division of labor over digital sharing platforms and the division of labor among autonomous entities (Li et al., 2021).

The digital platform organization goes beyond traditional hierarchical organizations by distributing resources to upstream and downstream companies and bringing together resources for customers and users to help them overcome limitations in resources and business scopes. In contrast to the traditional market organization, the digital platform organization extends beyond mere contractual relationships. Although there is no direct affiliation between individuals, between organizations, and between individuals and organizations, there exists a relationship of complementarity and symbiosis among organizational members. These organizations create a community of like-minded individuals, blurring the lines between internal and external boundaries.

In the era of the digital economy, more and more individuals, innovation teams, entrepreneurs, and customers are collaborating on research and development and sharing innovation results. This collaboration is blurring boundaries between entities involved in innovation. The advancement of global industrial organizations allows for the efficient and convenient exchange of information and

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resources, facilitating the sharing of technologies, information, and knowledge to drive innovation and improve efficiency. New modes of production are flourishing, characterized by boundaryless digital platform organizations. Crowdsourcing, crowd innovation, and socialized production are examples of these thriving organizational forms. As an example, Xiaomi, a consumer electronics company, has adopted an Internet-based development approach. Its R&D personnel gather feedback on product improvements from social media platforms like Weibo, WeChat, and community forums. Four fifth of Xiaomi's mobile phone system updates have been influenced by suggestions from the online community, and one third of such updates are directly developed by users themselves (Du and Ning, 2016). In the long term, the trend towards a boundaryless tech community will encourage the free and open movement of resources in the context of fair competition.

Boundaryless digital platforms are revolutionizing the way businesses operate, enabling seamless connections between suppliers, distributors, and consumers across different regions. This virtual agglomeration facilitates the real-time exchange of digital information at incredibly low costs. Knowledge and technology spillovers result in the dispersion of corporate interests among different companies and sectors. The shift from closed geographical concentration to an open network of agglomeration is creating a more expansive market and fostering collaboration among businesses. This is helping to accelerate the benefits of economies of scale and economies of range. In today's interconnected and rapidly changing global market, virtual clusters have emerged as a fresh approach to industrial organization. This has led to a shift in international industrial distribution, with manufacturing and sales being decentralized to local markets. Virtual clusters have played a significant role in shaping the international division of labor and the structure of global industrial chains. They have brought about a refreshing change to the global industrial landscape by leveraging critical resources and comparative advantages of different countries.

3.4 Integration

Integration has become a prominent trend in industrial organization during the era of the digital economy. This has been brought about by the boundaryless development at the microscopic level. Integration can be seen in the merging of digital technology and the real economy, the blending of online and offline operations, the connection between different industries, and the combination of advanced manufacturing and modern services.

One aspect of digital applications in the real economy - identified by the Chinese government as a major driver for the growth of the digital economy and high-quality economic development - is the interaction between digitalization and industry. *The 14th Five-Year Plan for the Development of Digital Economy* calls for expanding China's digital economy by integrating digital technology into the real economy and fostering digital industrialization and industrial digitalization[4]. The Report to the 20th CPC National Congress emphasizes the need to expedite the growth of the digital economy and foster a deeper integration between the digital and real economies[5]. Online-to-offline (O2O) commerce is the most dynamic business model in which digital applications are integrated into the real economy, notably in the service sector. The advent of digitalization has facilitated the seamless integration of online and offline operations across various sectors, including retail, catering, tourism, office workers, education, and healthcare. Online business models such as e-commerce, digital payment systems, online delivery services, bike sharing, smart tourism, remote work, telemedicine, and livestreaming commerce have become popular in recent years. Digital applications have become increasingly prevalent in manufacturing and service sectors, and they are also gaining ground in agriculture, encompassing various

[4] Source: *Circular of the State Council on the Release of the 14th Five-Year Plan for the Development of the Digital Economy*, https://www.gov.cn/zhengce/zhengceku/2022-01/12/content_5667817.htm.

[5] Xi Jinping. Hold High the Great Banner of Socialism with Chinese Characteristics and Strive in Unity to Build a Modern Socialist Country in All Respects: Report to the 20th CPC National Congress. Beijing: People's Press, 2022, page 30.

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aspects from procurement to cultivation and distribution. The progress of agricultural digitalization is particularly notable in certain regions of China (Wang et al., 2023).

Digital technology has improved the development quality and risk resilience of industrial chains and ecosystems by integrating primary, secondary, and tertiary sectors. The digital economy has added value by combining agricultural cultivation, processing, and marketing, fostering the so-called "six industries".[6] New industries have emerged as a result of the merging of upstream and downstream processes made possible by advances in information technology. The expansion and integration of services into the primary and secondary industries is a clear indication of industrial upgrade. As an example, producer services in the tertiary industry are extending into various stages of the production process, including pre-production research, design during production, and post-production information feedback. This has led to a new industrial system that obscures the boundaries between industries.

Manufacturing-service integration is crucial for the seamless integration of the primary, secondary, and tertiary industries. It plays a crucial role in facilitating the transition and upgrade of manufacturing, as well as the development of manufacturing service platforms. This integration is achieved by expanding services into the manufacturing sector, resulting in service-based manufacturing. In the modern era of business, platform companies have created a new industrial ecosystem that benefits from the integration of manufacturing and services (Guo, 2019).

Central to the integration of primary, secondary, and tertiary industries is manufacturing-services integration, which plays a crucial role in driving manufacturing transition and the development of manufacturing service platforms. There are two pathways for manufacturing-service integration: service-based manufacturing and manufacturing-oriented services. In the age of the digital economy, manufacturing-service integration through digital technology has given rise to a new industrial ecosystem where platform companies take centerstage (Guo, 2019).

4. New Characteristics of Evolving Industrial Organization

The digital economy has transformed traditional industrial organization into a new paradigm with the following new characteristics.

4.1 Platform Companies Thrived amid Intensifying "Positional Arms Race"

Due to the "Matthew effect" brought about by the Internet's network effect and the "attention economy", only a handful of companies control most of the market for any given product or service[7]. That is why competing businesses place a high value on their relative market ranking, resulting in the inescapable "positional arms race". The term "positional arms race" refers to the constant competitive practices that competing organizations engage in to strengthen their market positions. It should be highlighted that these corporations seek to improve their relative ranking rather than their absolute economic performance, which is analogous to an arms race in which companies invest to improve their rankings and compete fiercely at the price of social and even individual well-being. In the digital market, firms have emphasized the following factors in descending order of significance while developing their competitive positioning: user base, usage, income, and lastly, profit. Companies are more motivated to recruit customers, improve transaction volumes, and extend their market shares than they are to maximize corporate profits or earnings per share (Zhang, 2023).

In the digital market, firms cannot rely exclusively on their own resources to win the "positional arms race" because it requires a significant amount of capital to outcompete, either by subsidizing users

[6] The term "six industries" refers to the addition (1×2×3) and multiplication (1+2+3) of primary, secondary, and tertiary industries, all of which equal 6.

[7] Only a couple of companies will win in market competition, and even the third and fourth players have a tiny chance of success, let alone those with even lower ranks.

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or gobbling up rivals. As a result, it is inevitable for external money to enter the fray. From platform companies founded around 2000, such as Baidu, Alibaba, Tencent, and JD.com, to latecomers founded after 2010, such as Toutiao (Douyin), Meituan, Didi Chuxing, Kuaishou, and Pingduoduo, these companies grew from minnows to giants in terms of market capitalization and active users in less than a decade. Such rapid expansion was previously unthinkable in the industrial economy, but it has been made possible by the intervention of external capital. By the end of 2022, Baidu, Alibaba, Tencent, JD.com, Meituan, and Kuaishou had market capitalizations of 345.2 billion yuan, 1.76 trillion yuan, 2.92 trillion yuan, 420.5 billion yuan, 775 billion yuan, and 267.1 billion yuan, respectively. Continuous external financing has driven platform firms' rapid growth. Access to external financing is critical for platform companies at the early stages of development in order to expand their user base, overcome barriers to generating network effect, and survive competition.

4.2 Market Structure of "Hierarchical Monopolistic Competition" and Monopolistic Competition Landscape of "Coexistence without Disruption"

According to the conventional industrial organization theory, perfect competition and perfect monopoly are at opposite ends of the market spectrum, and competition and monopoly have a substitutional relationship: A more competitive market is less monopolistic, and vice versa. In the market structure of digital economy platforms, competition and monopoly may be complementary rather than substitutive. Unlike traditional theories and perspectives on industrial organization, digital economy platforms can become both competitive and monopolistic.

The network effect causes consumers and data resources to gravitate toward a few top platforms, and every market sector is riddled with concentration and oligopolies. In China, numerous digital platform segments have developed into monopolistic or oligopolistic marketplaces. The top four businesses control more than 90% of markets such as e-commerce live streaming, search engines, instant messaging, online music, mobile payment, game livestreaming, and online delivery. In other markets, such as ride-hailing, online retail, web video, and entertainment livestreaming, the top four companies have a market concentration of more than 80%. In most sectors, a small number of top digital economy platforms control the majority of the market share, resulting in a high market concentration (Policy and Economic Research Institute at CAICT).

In contrast to the industrial economy era, digital platforms can be competitive as well as monopolistic. In some circumstances, the intensity of competition may be directly proportional to the level of monopoly. On the one hand, Internet platforms tend to produce a highly centralized market structure, indicating the presence or tendency of monopoly. On the other side, low market barriers have resulted in an influx of players in a competitive market. The high market concentration and low barriers indicate a coexistence of monopoly and competition. The unique market structure of Internet platform companies can be described as "hierarchical monopolistic competition", in which large Internet platforms and their main businesses form the layer of monopoly while small and medium-sized Internet platform companies and their derivative businesses dominate the layer of competition without affecting the layer of monopoly (Su et al., 2018). While acknowledging the intensification of industry monopoly and competition, "hierarchical monopolistic competition" emphasizes a distinct relationship between monopoly and competition in a given industry: The relationship of monopolistic competition that promotes "coexistence without disruption" has evolved into a unique market structure for Internet platform companies. Such a market structure is very likely to evolve spirally in accordance with a pattern of "coexistence between competition and monopoly that leads to a higher degree of competition", causing platform competition and monopoly to increase simultaneously.

Innovation is a crucial tool for breaking up monopolies through "innovative destruction". In the platform economy, however, such "creative destruction" is minimized by giant digital platforms leveraging their network effects, user base, and financial muscle to acquire small and medium-sized

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innovative enterprises that may threaten their superiority. In many instances, platform companies can easily carry out mergers and acquisitions, resulting in new forces in the sector. By acquiring innovation resources, leading digital platform companies have raised market barriers in the digital economy, making it difficult for SMEs to break industry monopolies through business model innovation and thus solidifying such "hierarchical monopolistic competition" structure (Su et al., 2018).

4.3 Increasing Cross-Border Expansion and Ecosystem Competition

In the digital economy era, technological innovations have blurred the line between industries. With their advantages in capital, user base, network effect, data, and algorithms, digital platform companies are constantly expanding their business scopes through mergers and acquisitions to create industrial ecosystems. According to the Commercial and Administrative Law of the Committee on the Judiciary (2020), by the end of 2020, the four platform companies - Facebook, Amazon, Apple, and Google (FAAG) - had acquired hundreds of companies (including 88 by Facebook, 104 by Amazon, 122 by Apple, and 257 by Google) to expand their business into dozens of sectors from software to hardware, cloud services, AI, social networking, entertainment, and healthcare. Table 2 shows the historical facts of the four platform businesses that have been conducting varied mergers and acquisitions and increasing their business scope, based on data from the *Report on the Survey of Digital Market Competition*.

Table 2: Four Platform Companies Expanding Their Business Scopes through M&As

Platform companies	Type[a]	Merged companies[b]	Amount of M&A (100 million US dollars)[c]
Facebook	Software development	Giphy, WhatsApp, Chainspace、Fayteq, Chai Labs	194.2
	AR/VR	Scape Technologies, Ready at Dawn, Beat Games, Culus VR	20.4
	E-commerce	LiveRail, Atlas Solutions, Onavo, Push Pop Press,	6.0
	Social media, entertainment and education	Pebbles Interfaces, Branch, Instagram, Drop.io	2.5
	Artificial intelligence (AI)	GrokStyle, Servicefriend, Bloomsbury AI, Face.com	1.3
	Others (cloud service, consumer electronics, etc.)	QuickFire Networks, Parse, Chainspace, Hot Studio, Endaga, Ascenta	—
Amazon	Healthcare and food	Health Navigator, Whole Foods	137.0
	E-commerce	Sizmek Ad Server, Tapzo, PillPack, Blink, GameSparks, Souq.com, Quidsi, BuyVIP	41.1
	Education and entertainment	Twitch, LoveFilm, Audible, Westland, TenMarks Education	16.4
	Software development	Elemental Technologies, Evi, Kiva Systems, Convergence Corp.	13.2
	Artificial intelligence	Zoox, CANVAS Technology, Graphiq, Harvest. AI	12.7
	Cloud data service	E8 Storage, CloudEndure, TSO Logic, Annapurna Labs	6.0
	Internet security	Bebo, Eero, Sqrrl	1.6
	Others (3D technology, mobile payment, courier services, etc.)	Body Labs, Goo Technologies, UpNext, Small Parts Inc., Immedia, Emvantage Payments	—
Apple	Software and hardware development	Mobeewave, Intel Smartphone Modem Business, Shazam, LinX, Beats Electronics, Topsy	52.2
	Semiconductor	Dialog, Anobit, Intrinsity, P.A. Semi	10.9
	Digital entertainment and education	Redmatica, Lala, Xemplar Education, NeXT	4.3
	Artificial intelligence	Xnor.ai, Turi, Prismo Graphics, Inductiv	4.2
	Information technology	Novauris Technologies, AuthenTec, Spruce Technologies	3.7
	3D technology	iKinema, PrimeSense, Raycer Graphics	3.6
	Others (cloud services, graphics processing, AR/VR, etc.)	Stamplay, Lattice Data, NextVR, Spaces, DataTiger, InVisage, Polar Rose	—

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Table 2 Continued

Platform companies	Type[a]	Merged companies[b]	Amount of M&A (100 million US dollars)[c]
Google	Software development	Pointy, Superpod, Bebop, Waze, Motorola Mobility	147.7
	E-commerce	Channel Intelligence, BufferBox, Zagat, DailyDeal, Admeld, DoubleClick	49.5
	Cloud data service	Looker, Apigee, Orbitera, Skybox Imaging	38.3
	Healthcare and health	Fitbit, Senosis Health, Lift Labs	21.0
	Hardware manufacturing	North, HTC Smartphone Division, Dropcam	19.0
	Social, entertainment and education	Aardvark, Gizmo5, Feedburner, YouTube	18.8
	Information technology	Sparrow, Meebo, ITA Software, Postini	15.8
	Artificial intelligence	Halli Labs, Moodstocks, DeepMind Technologies, Wavii	5.3
	Others (AR/VR, 3D technology, biomedical, etc.)	Viewdle, Picnik, Thrive Audio, MentorWave Technologies, Nest Labs, Wildfire Interactive, DocVerse	—

Note: (i) Companies are classified based on categories in the original data. (ii) Since original information contains numerous companies, only the representative companies are listed here in the interest of length. (iii) Due to missing M&A data in the original data, the M&A amount listed in this table is incomplete statistical results.
Source: Commercial and Administrative Law of the Committee on the Judiciary, 2020, "Investigation of Competition in Digital Markets", https://democrats-judiciary.house.gov/uploadedfiles/competition_in_digital_markets.pdf.

In China, Baidu, Alibaba, Tencent, and JD.com have extensive operations in finance, technology, education, healthcare, and gaming sectors, primarily through M&As such as buyouts and strategic investments, with the majority of M&As occurring in retail e-commerce, finance, technology, culture, and entertainment (2018-2022). In 2019, Baidu, Alibaba, Tencent, and JD.com completed 45, 81, 121, and 32 mergers and acquisitions, respectively. Such cross-sectoral business expansion has resulted in increased similarities and even overlaps in the business scopes of major platform companies, forcing them to compete in a greater range of industries.

Unlike traditional businesses, which compete in the same market, platform companies frequently compete across industries and ecosystems. They resort to an envelope strategy for cross-industry competition into other sectors. Platforms and digital technologies have linked the innovation, industrial, supply, and value chains to create a symbiotic industrial ecosystem (ecosphere) (Yu and Li, 2021). In the digital economy era, corporate or industrial competition takes the shape of competition between industrial ecosystems and competition of overall strengths such as hard power, soft power, platforms, and services rather than competition between products or services.

The conventional notion of industrial organization does not typically include industrial ecosystems. An industrial ecosystem is neither an industry nor an individual firm; it is not even a part of an industry or a niche market. Instead, an industrial ecosystem includes multiple sectors and serves as a bridge between the industrial and corporate layers (Zhang, 2023). Corporate conglomerates can be compared to ecosystems; however, a digital industrial ecosystem is far more open and covers a wider range of sectors. For example, smartphones and their operating systems constitute an ecosystem, with Apple and its iOS at the center. This ecosystem includes a large number of supply chain organizations, processing and assembly companies, studios, technology developers, software developers, and loyal customers. Aside from the ecosystem centered on Apple and iOS, there are other smart phone ecosystems supported by Google and its Android, as well as Microsoft and its Windows mobile operating system. The food chains and dependencies in these ecosystems are exceedingly complex.

Digital industrial ecosystems have boosted the economic potential of the digital economy while challenging regulatory notions and approaches developed throughout the industrial economy era. Industrial ecosystems are not regarded a unit of analysis or a regulatory object in the classic industrial organization theory. The sub-industrial ecosystem heavily influences industrial behaviors and

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development, but unlike industrial conglomerates, it lacks a formal organization, potentially leaving a grey area and hazy space for regulatory supervision. Furthermore, the ecosystem symbolizes a new organizational structure that connects the real and virtual worlds, resulting in a sub-society that transcends physical and geographical boundaries. The merging of the real and virtual worlds expands the digital industrial ecosystem from three to four dimensions, potentially increasing the stickiness and distortion of the three-dimensional environment (Zhang, 2023). Without a doubt, increased complexity will create new questions.

4.4 Data and Algorithms: Secret Weapons Driving Platform Companies' Monopolistic Power

The digital economy period is marked by the advent of data as the new generic asset, algorithms as the new generic technology, and digital tools as a new mode of production and way of life. Data and algorithms align supply and demand in an accurate, efficient and cost-effective manner. On the flip side, they also act as formidable weapons, limiting competition and increasing monopoly. For example, differentiated treatment and discriminatory behaviors based on data and algorithms are already prevalent in the market. Some platform companies use big data to overcharge loyal customers. Other examples of data abuse are self-preference and refusal to deal. In the digital economy, competition is dynamic and organizational in nature and is based on users, data, algorithms, flow, and attention rather than static product competition among traditional manufacturers based on scale, range, price, and brand (Xie and Wu, 2021). As one of the most potent competitive assets in the digital economy, data-driven algorithms are used by platform companies to increase competitiveness and pursue monopolistic advantage. Platform companies leverage user data, particularly cross-sectoral and multidimensional user data, to convert one set of data into a competitive advantage in several market segments. They then use self-reinforcing positive feedback to increase user stickiness and strengthen their monopolistic advantage.

When dominant digital platforms have strong market forces due to their advantageous data, algorithms, transaction volume, and basic service capabilities, there is a leverage effect that extends their competitive and monopolistic strengths to other sectors, transforming their initial monopoly into a multisectoral monopoly (Li and Xia, 2020). For example, Google uses its search algorithms to push advertisements to its customers, while Tencent uses its algorithms to grow its monopolistic edge in social media and offer games to its users based on self-preference. They create challenges that extend beyond monopoly and unfair competition in the narrow sense. Abuse and discrimination based on algorithms exploit human flaws and cause major social problems. For example, high-frequency push depending on user patterns encourages addictive or so-called immersive experiences (Zhang, 2023).

5. Effects of Evolving Industrial Organization

The digital economy has established a new paradigm, resulting in new contradictions that drive its continued growth. The existence of various underlying contradictions in the digital economy drives the evolution of industrial organization while also presenting new opportunities and challenges. According to research, five inherent contradictions exist between the physical and digital worlds, specifically between the digital factor and smart enabling capabilities, the algorithm-based economy and information cocoons, open access to data and privacy protection, and emergent properties and reductionism (Yang and Li, 2021).

In our opinion, the evolution of industrial organization in the digital economy era contains at least the following inherent contradictions: monopoly versus competition, dataflow and transaction versus data security and protection, data platform development versus regulatory supervision, and the use of digital technology to develop digital platforms versus its use to regulate digital platforms. The unraveling of these contradictions creates opportunities as well as challenges for the evolution of industrial organization in the digital economy.

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5.1 New Opportunities

5.1.1 New industries, business models and paradigms help overcome the "Baumol's cost disease"

As a prominent new form of industrial organization, the platform economy has become a vital driving force for "mass entrepreneurship and mass innovation", propelling China's economic transition. China's platform economy, built on the Internet, big data, and AI, includes a wide range of applications and services like e-commerce, social media, and the sharing economy. Internet platforms have created multiple Internet ecosystems by connecting a diverse range of producers and customers, allowing for network-based product design, creativity, production, exchange, distribution, use, and services. With the growth and integration of block chains, AI, 5G, virtual reality (VR), and augmented reality (AR), the platform economy is creating new business ecosystems. Digital platform businesses have emerged as crucial vehicles for the creation of new economic entities through industrial integration and business model disruption. With the help of digital technology, China's platform companies have thrived in a massive domestic market. They have become champions in their specific fields, ranging from online retail to ride-hailing and mobile payment, thanks to a combination of online and offline strengths, outpacing overseas competitors in scale.

China has reached an era of economic growth that is dominated by services. According to developed countries' experience, countries at this stage are susceptible to the "Baumol's cost disease", which refers to diminishing total economic output as a result of high service sector costs and poor labor productivity while the service sector's share of the economy grows. Under traditional conditions, high costs in the service sector are due to the characteristics of services, i.e. services are intangible, service delivery and consumption occur concurrently and at the same place, services cannot be stored for later consumption, and differences exist between individual services. These characteristics help to explain why the traditional service sector lacks scale economies and technological progress. Since the Industrial Revolution, technological development and economies of scale have not been reflected in service sector progress, and the service sector has been held down by low productivity (Jiang, 2021a).

In the digital economy age, the service industry has been changed by advances in digital technology and industrial organization tendencies toward networked, platform-based, boundaryless, and integrated development. Specifically, the emergence of service-related new sectors, business models, and paradigms has increased service sector efficiency. The extensive use of digital technology has reduced the marginal cost of various network services, despite their high initial cost, resulting in significant network, scale, and range economies. This effect is especially noticeable in information and cultural services, which are reproducible. For example, online educational programs and textual content can be watched an unlimited number of times for a low marginal cost. Such economies of scale are extraordinarily large, surpassing those of modern industry. Digital industrialization and industrial digitalization have given rise to new industries, business models, and paradigms such as platform-based design, smart manufacturing, Internet-based coordination, and customization, which will promote the integrated development of modern services, modern agriculture, and advanced manufacturing, thereby improving the economic efficiency and profitability of agriculture, manufacturing, and services (Qi and Jiang, 2023).

5.1.2 Data-driven cross-border trade in services is poised to grow significantly

In the digital economy era, the networked, platform-based, and boundaryless industrial organization has significantly reduced the cost of cross-border and cross-sectoral links, increased return, accelerated cross-border cooperation, and resulted in significant growth in data-driven cross-border trade in services. The emergence of digital globalization has resulted in a fresh round of dividends from globalized resource allocation and industrial division of labor, increasing the likelihood of post-pandemic economic recovery and long-term growth. After 2016, global trade and investment volume increased at a faster rate than global GDP growth. The digital economy, technology, and trade have all

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played significant roles in this process. In recent years, digital trade has taken a larger share of global trading services, exceeding 50% by 2020 (Jiang, 2022).

Digital trade service platforms have significantly influenced the current global trade landscape. Digital trade service platforms have enabled the intelligent matching of multiple suppliers and clients via digital platforms, which not only improves efficiency but also meets a wide range of individualistic needs. This trade pattern was previously inconceivable. For example, the Boeing 787 is the result of design and service platforms that brought together top-tier engineers from around the world to collaborate on R&D using digital technology. Over the platform, around 1,000 engineers from more than 30 nations were constantly designing airplane parts and components (Jiang, 2022). Furthermore, digital platform companies have implemented a globalized internal governance framework. They are involved in the governance of both the domestic and foreign trade markets. In the event of a trade dispute, the parties will adhere to the platform's dispute resolution rules, which are more efficient than international consumer complaint and compensation systems. Third-party norms for dispute resolution are easier to accept, more efficient, and less expensive to enforce.

5.1.3 Data-based social governance promotes smart regulation

In the digital economy era, platform-related online and offline transactions face a wide range of difficulties such as transaction enforcement, product safety, financial security, refund and exchange of goods, dispute resolution, intellectual property rights, and unfair competition. Historically, government entities were responsible for resolving these concerns. However, as the platform economy grows, it becomes increasingly difficult for the government to regulate a huge number of high-frequency transactions on the platform. In this setting, it has become vital to engage the "visible hand" of platform businesses, establish a self-regulatory order for platforms, and foster collaborative governance between platform companies and government regulators.

As a novel type of organization, platforms have robust resource allocation capabilities that combine attributes of both corporations and markets. Meanwhile, they also have the power to create and enforce platform transaction rules, simultaneously acting as both a participant and an arbitrator. Utilizing platform functions and digital technology allows for the integration of external platform supervision and self-regulation, enabling the implementation of Internet-enabled smart regulation and fostering collaborative supervision and governance. China has achieved success in this regard. For example, the efforts to combat counterfeit products in e-commerce demonstrate effective collaboration between regulatory authorities and platforms. One advantage of e-commerce platforms is that they have the ability to detect and remove fake or unauthorized products. Additionally, the utilization of big data monitoring technology enables platforms to detect valuable information regarding counterfeit or infringement commodities. This information is then promptly reported to regulatory agencies, resulting in the precise and efficient seizure of counterfeit products.

5.2 New Challenges

5.2.1 Platform companies are becoming a growing concern due to their monopolistic practices and anti-competitive behavior

Based on the Investigation of Competition in Digital Markets research report, it is evident that the digital economy has experienced a notable increase in concentration over the last decade, leading to an alarming trend of monopolization. In various sectors, such as online retail, social media, online search, and online advertising, a few platform companies tend to dominate the market. Amazon, Apple, Facebook, and Google have already established dominance over key distribution channels in various sectors, assuming the role of "gatekeepers" (Commercial and Administrative Law of the Committee on the Judiciary, 2020).

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Without a question, platform monopolies constitute a rising concern in China. Monopoly by leading platform companies can be attributable to the following factors. First, economies of scale: It takes a significant upfront investment to build infrastructure and information collection and dissemination networks for Internet information services. However, once such services are marketed, their almost zero marginal cost and high return create economies of scale, allowing platform companies to distribute costs over their huge user base and thereby build a monopoly. Second, network effect refers to the externalities created by platform entities for other entities. With network development, firms will provide better services and attract more consumers, resulting in a market landscape in which a winner takes all. Third, a two-sided market: Consumer value is largely determined by the number of sellers in the market. The more vendors, the more options consumers will have, and the fiercer the competition between sellers, the better for consumers. For sellers, the broader the user base on a platform, the greater the value that may be obtained. The two-sided market effect creates a positive feedback loop between customers and producers, which increases the market concentration of major platforms. Fourth, user stickiness: Platforms exploit their early-mover advantage to instill user habits or give consumer preferences that make switching to other platforms more expensive, boosting user stickiness and preserving their monopoly. Fifth, data and algorithms: Advances in big data, cloud computing, and AI have catapulted the platform economy into a new era of data and algorithm-driven development, strengthening platforms' monopolistic dominance (Yu, 2021).

In the digital economy era, certain platform companies strengthen their dominating market position by leveraging economies of scale, network effect, cross-market spillover of advantages, and multi-business data integration. In certain circumstances, platform firms use their dominating market position to exclude and limit competition. The widespread expansion of platform companies into various sectors, as well as intervention in the financial market to form platform-financial complex monopolies, not only disrupt the competitive order, innovation, and consumer rights, but may also destabilize the national financial system with far-reaching consequences (Xie and Wu, 2021).

In contrast to the readily apparent anticompetitive behaviors of monopolistic enterprises in the traditional economy, super-platform companies may engage in even more implicit anticompetitive and monopolistic behaviors in the digital economy era through algorithm collusion, cross-sectoral competition and M&A, and operator concentration.

Collusion is a typical anticompetitive behavior committed by parties through express or tacit agreement. In the digital economy era, algorithm-based collusion is an unprecedented new type of collusion. It is a novel type of tacit collusion carried out using smart algorithms that are independent of operator or consumer intervention (Qi et al., 2021). According to the OECD's (2017) research, rapid algorithm development and the lack of transparency in smart algorithms enable competitors to collude through sophisticated computer codes. Platform companies have developed a "black box" of algorithms to quickly and accurately capture and analyze competitors' price data and set their own prices to form a collusion, which is more implicit than many rounds of consultations or the execution of a written agreement between competitors to form a collusion (Wu and Tan, 2020).

Platform companies covertly leverage M&As and cross-sector competition to increase their monopoly. In the digital economy era, predatory M&As have become a target for antitrust enforcement. Unlike typical M&As, predatory M&As are driven mostly by large platforms, particularly super-platforms, with the goal of thwarting future competition or innovation. It includes horizontal M&A, vertical M&A, and cost-sector integration (Wang, 2022). Platform businesses must pay a price significantly higher than the market valuation of a startup business or the purchase price offered by other bidders when engaging in predatory acquisition. They must also be willing to accept potential long-term losses following the transaction. Predatory acquisitions have resulted in the loss of new products and services, reducing innovation and fair competition.

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In the United States, four Internet behemoths - Microsoft, Google, Facebook, and Amazon -completed 175 M&As between 2018 and 2020, with 105 of related projects being terminated within one year of acquisition, resulting in the suspension of products and services by startup companies (Gautier and Lamesch, 2021). Among the 616 M&A transactions each valued over 1 million US dollars conducted by the five leading platform companies (Amazon, Apple, Facebook, Microsoft, and Google) between 2010 and 2019, 65% had a transaction value of 1 million to 25 million US dollars, and at least 39.3% of the acquired enterprises had been in operation for less than five years[8]. In China, operator concentration and M&As in the digital economy skyrocketed. Before October 2020, Tencent participated in 756 M&As and Alibaba in 531 M&As throughout e-commerce retail, finance, technology, cultural, and entertainment industries without facing a single antitrust probe, and none of these M&As were reported to law enforcement agencies (Wang, 2021). One important reason is that Internet giants like Alibaba and Tencent have adopted a variable interest entity (VIE) architecture, in which the acquiring company gains control of subordinate companies through a series of agreements rather than direct investment, thereby avoiding antitrust supervision (Yang and Li, 2021). By December 2020, the General Administration of Market Supervision had imposed an administrative penalty on Alibaba Investment Co., Ltd. for failing to declare operator concentration when it acquired a stake in Yintai Commerce (Group) Co., Ltd. It wasn't until then that Internet platform companies became more cautious about adopting the VIE architecture to avoid regulatory scrutiny[9]. The enactment of the *Anti-monopoly Guidelines of the State Council Anti-Monopoly Committee for the Platform Economy*[10], which states that "operator concentration involving agreement-based control architecture is subject to anti-monopoly review", officially corrected the disorderly operator concentration of Internet platforms (Wang, 2022).

5.2.2 Data aggregation highlights privacy protection and security issues

In the digital economy era, data has emerged as an essential new factor of production. Digital platforms' competitiveness is mainly determined by their ability to acquire appropriate data resources and analytics. Large platforms collect user data and use algorithms and big data to precisely push services to users based on user portraits. While algorithms and big data allow for more efficient and convenient services for consumers, they also make it simpler for monopolies to expand horizontally or vertically at the price of consumer welfare. For example, commercial digital platforms may tailor services and marketing to specific customer preferences in order to find and overcharge repeat customers. Content digital platforms deliver individualized messages to customers, forming an "information cocoon" where recipients are fed daily news articles that match their preferences. All such practices violate consumer interests.

Given the open, editable, and transferable nature of data, platform companies' widespread acquisition and use of data not only violate consumer privacy and harm consumer welfare, but also raise severe social governance and national security concerns. The Didi Chuxing story serves as a painful lesson. Didi Chuxing allegedly committed 16 infractions of eight types by collecting information about passengers' identities, face images, conversations, travel records, locations, and service ratings on a regular basis. In addition to compromising passenger privacy and security, the regular leaks of large amounts of information have constituted a severe threat to national security[11].

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[8] Source: *Five tech giants including Apple and Google acquired 616 startups in 10 years,* https://www.chnfund.com/article/AR20210917095335340410 77.

[9] Source: *Announcement of the General Administration of Market Supervision on the Decision of Administrative Penalty against Alibaba Investment Co., Ltd. in connection with its Acquisition of a Stake in Yintai Commerce (Group) Co., Ltd. without Declaring Operator Concentration*, https://www.sac.gov.cn/cms_files/filemanager/samr/www/samrnew/fldes/tzgg/xzcf/202204/t20220424_341874.html.

[10] Source: *Anti-monopoly Guidelines of the State Council Anti-monopoly Committee for the Platform Economy*, https://www.gov.cn/xinwen/2021-02/07/content_5585758.htm.

[11] Source: *Officials from the National Cyberspace Administration answer questions from the press regarding decisions of administrative penalty on Didi Global Co., Ltd. for breach of Internet security*, http://www.cac.gov.cn/2022-07/21/c_1660021534364976.htm.

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5.2.3 Digital platforms elude antitrust identification and investigation

Antitrust analysis is based on a reasonable definition of the relevant market. The rising challenge of defining the relevant market in the digital economy has become the first hurdle to antitrust enforcement against digital platforms. In the digital economy, there is a positive feedback effect as a result of two-sided or multi-sided markets and free products. As a result, the definition of a relevant market becomes either too limited or too broad. The introduction of new technologies, industries, business strategies, and paradigms has blurred the lines between diverse sectors, making it even more difficult to define market boundaries. From a demand substitution standpoint, shifting customer preferences in the digital economy make it more difficult to assess the substitutability of products or services. In terms of supply substitution, rapid innovation in the digital market has raised ambiguity in determining substitutability among suppliers (Xiong, 2019). Given the existence of "zero price" or "negative price", it has become unfeasible to define the relevant market based on "small but significant and non-transitory increase in price (SSNIP)" as a price-based test of hypothetical monopolists. Alternatively, academics came up with the "small and significant non-transitory decrease in quality (SSNDQ)" test method, critical loss analysis method, and so on. However, these methods have seldom been implemented due to difficulties to measure quality, collect data, and properly conduct the test.

Even if a solid method for defining the relevant market exists, it is hard to determine market dominance in the digital economy. Traditional market domination criteria, such as market share, price level, product differentiation, and profitability, are significantly less useful in the digital economy. The zero-price strategy, two-sided or multi-sided markets, and dynamic cross-sector competition make it harder to recognize monopoly in the digital economy than in the past (Chen and Ma, 2021). Platform companies have tremendous market positions and dominance despite their little market share determined using low data and information prices, which may even be free of charge. Platform dominance should be judged by barriers to market entry rather than market share. Furthermore, regulators should consider economies of scale, network effect, data and algorithm discrimination, user conversion cost, consumer preferences, and web traffic as potential barriers to market entry in the platform economy.

Identifying the abuse of market dominance is difficult both theoretically and practically. The standard "structure-behavior-performance" analytical approach shows a negative relationship between market concentration and efficiency. In the digital economy, however, a multi-sided market generates higher positive network externalities, and the benefits of high efficiency outweigh the negative impacts of monopoly. It is therefore necessary to determine whether there is an abuse of market dominance in the platform economy based on a comprehensive set of criteria, which should include the effective protection of consumer rights, the preservation of positive competition in the digital market, and the promotion of innovation and the ecosystem for innovation (Li et al., 2022).

Investigating monopolies in the digital economy is expensive. Law enforcement is complicated by new technologies like algorithms, big data, and platform rules, as well as a lack of transparency in corporate operations. While determining whether a corporation violates antitrust law requires significant resources, law enforcement agencies must also have expert knowledge of digital technologies in order to undertake antitrust investigations. Consider the European Union's lawsuit against Google. Due to the complexity and "black box" of algorithms, the European Commission engaged numerous experts to analyze 1.7 billion entries of data over a seven-year period to conclude that Google had manipulated algorithms to abuse its market dominance (Deng and Dai, 2017).

6. Conclusions and Policy Suggestions

In the digital economy era, data has become the most significant production factor. The enabling force of digital technology, as well as the convergence of the digital and real economies, have given rise to new industries, business models, and paradigms that are driving our economy's digital transition and

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high-quality development. The digital economy has transformed the logic and rules of the industrial economy, reshaping industrial organization into a networked, platform-based, boundaryless, and integrated development pattern. Platform companies have been growing from strength to strength amid an intensifying "positional arms race" driven by financial capital; the "coexistence without destruction" pattern of monopolistic competition took shape amid the emergence of a market structure characterized by "hierarchical monopolistic competition"; and competition between industrial ecosystems holds sway as platform companies expand into more segments. The evolution of industrial organization has shown the following new trends and characteristics: On the one hand, the platform economy has provided great opportunities for innovation, entrepreneurship, consumer welfare improvement, greater convenience and lower cost for cross-border cooperation, and social governance improvement. On the other hand, platform monopolies present challenges to competition, antitrust regulation, privacy protection, and security issues. These issues not only restrict fair competition and hurt consumer interests, but they also jeopardize national security and create new requirements for enhancing industrial regulation in the digital economy. In view of these opportunities and challenges, we must adapt to the rapid changes in industrial organization in the digital economy era, leverage opportunities, navigate challenges, and strengthen governance and regulation under the digital economy paradigm.

Improving governance and regulation under the digital economy paradigm: First, new rules should be created through practical exploration. For example, it requires continuing investigation to decide what should be done to establish data rights and assets, how to draw the line between data openness and data protection, and what policies should be followed to facilitate cross-border data flow. Second, important relationships must be effectively managed in order to strike a balance between antitrust legislation and innovation, boost the digital economy's global competitiveness, and prevent platform monopolies and chaotic capital expansion.

Based on the above research findings, we propose the following policy suggestions to facilitate regulatory transition in the digital economy age and strengthen governance and regulation under the digital economy paradigm:

First, *ex-post* static regulation should be replaced with dynamic regulation with an emphasis on *ex-ante* and interim regulation. In the digital economy era, antitrust should not only change from structuralism to behaviorism, but also improve *ex-ante* and interim regulation on a dynamic basis, and impose *ad hoc* measures as needed. Antitrust is not designed to hinder businesses from growing larger and stronger. It is meant to target specific practices that violate the antitrust law, rather than to harm the market positions of certain firms. Structural split is just an exception to the antitrust law enforcement. Conventional law enforcement is complicated by network externalities, data-driven and cross-sectoral characteristics of the digital market, as well as challenges such as highly vibrant industrial innovation, privacy, and labor rights. As a result, countries have recognized the necessity of *ex-ante* regulation. For example, the European Union's *Digital Service Act* and *Digital Market Act* emphasize that major platform firms should face *ex-ante* requirements for their competitive behaviors and conduct self-assessment of competition compliance. As stated by the Competition and Markets Authority (CMA) in 2019, the "CMA needs to enforce *ad hoc* measures to restrict suspected acts of monopoly that are expected to inflict major damages to the affected companies in the event that antitrust cases take years to resolve" (Xiong and Han, 2022). Such dynamic regulatory approaches are worth considering for China's regulatory authorities as they seek to improve *ex-ante* and interim regulation.

Second, oversight should prioritize the monopolistic expansion of platform companies and their ecosystems. Previously, antitrust legislation was concerned with individual business practices that might exclude and restrict competition, as well as inter-firm behaviors like operator concentration and cartels. Industrial ecosystems received relatively little attention. In the digital economy, antitrust legislation should prioritize platform companies and their ecosystems, particularly data-driven monopolistic ecosystem expansion. First, regulators should concentrate law enforcement efforts on

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new forms of refusal to deal, such as prohibiting competitors from providing web links and preventing interoperability, as well as new forms of unfair competition, such as the abuse of data, algorithms, and other digital technologies, together with the abuse of platform and ecosystem positions. It is suggested to enforce interoperability requirements on major platform firms as needed. Many governments have implemented interoperability standards to increase competition in the telecommunications, fintech, and software industries. Interoperability enables platform operators to transfer and share data across many platforms, allowing users to migrate between platforms in a competitive market (Liu, 2022). Second, digital platform companies should be required to disclose operator concentrations. It is important to clarify that operator concentration including agreement-based control architecture is subject to antitrust review. Regulators should be on the lookout for digital platform firms gobbling up startups through the disorderly expansion of financial capital in order to prevent predatory acquisitions. Third, regulators should prioritize antitrust law enforcement by prohibiting hub-and-spoke conspiracy[12] in addition to horizontal and vertical monopoly agreements. Platform rules, algorithm advantage and secrecy, data advantage, and platform companies' bargaining leverage over tenant merchants all create a fertile ground for the negotiation and execution of hub-and-spoke conspiracy. It is advisable for regulators to contemplate the potential adoption of hub-and-spoke conspiracy by platforms, as delineated in the *Anti-monopoly Guidelines of the State Council Anti-Monopoly Committee for the Platform Economy*[13]. When conducting antitrust regulation over hub-and-spoke conspiracy, regulators must fully consider the market positions of platforms and their tenant merchants, as well as their contributions to the conclusion of hub-and-spoke conspiracy and the occurrence of monopolistic behaviors, to determine their respective share of responsibilities.

Third, one-way government regulation should give way to government-led multi-stakeholder governance. It is critical to strengthen the multi-stakeholder governance system by establishing clear rights and obligations and providing suitable incentives. National regulators, industry associations, chambers of commerce, consumer associations, media organizations, and other third-party entities should be fully involved in overseeing Internet platform companies and developing a multi-stakeholder antitrust regulatory framework. There should be more regulatory coordination in consumer protection, data security and privacy protection, governance of the digital content ecosystem, and labor rights protection for new forms of employment, to avoid the fallacy of composition and the fallacy of division[14] (Xiong and Han, 2022). The multi-stakeholder governance strategy emphasizes major platform companies' role as regulatory partners. Super-platforms should act as gatekeepers for the large high-frequency transactions to build a self-regulatory system. Platform companies should strive to build comprehensive transaction rules for customers in a vulnerable position in order to foster trustworthy transaction relationships and a secure transaction environment. In the collaborative governance environment involving platform companies and regulators, platform companies must take initiatives to maintain transaction order in their ecosphere, resulting in a self-regulatory system supported by regulatory oversight. In addition to preserving regulatory resources, this dedicated approach protects consumer interests in the platform economy, facilitates dispute resolution, and preserves intellectual property rights (Jiang, 2021b).

Fourth, improving tech-enabled data governance and algorithm supervision. In the digital economy era, regulators should concentrate on anticompetitive practices such as illegal data acquisition and

[12] Hub-and-spoke conspiracy is also referred to hub cartels. Hub-and-spoke conspiracy has a *de facto* horizontal monopolistic effect that platform merchants enter into through vertical relationships with the platform operator or the platform operators' coordination.

[13] Source: *Anti-monopoly Guidelines of the State Council Anti-Monopoly Committee for the Platform Economy*, https://www.gov.cn/xinwen/2021-02/07/content_5585758.htm.

[14] Fallacy of composition means what is correct and reasonable for individual measures in various sectors could be wrong if those measures are implemented in combination. Fallacy of division means the division of an indivisible task intended to clarify responsibilities and create motivations but actually resulting in the decomposition into excessive subtasks that potentially lead to disarray and mutual contradictions (Xiong and Han, 2022).

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use, as well as algorithm manipulation. In terms of data, focus should be given to data-driven mergers and acquisitions, as well as data source blockage by large corporations that dominate specific data sets. Certain acts of refusing to provide data must be regulated under the "essential facilities" basis of antitrust legislation. In terms of algorithms, focus should be given to algorithm collusion, algorithm discrimination, and other behaviors that harm consumers and competitors, particularly small and medium-sized businesses (SMEs). Data and algorithms necessitate the use of complicated digital technology, as does their regulation. As a result, focus should be given to using digital technologies to implement antitrust laws, as well as employing digital technologies such as the Internet, cloud computing, big data, AI and blockchain to improve digital regulation. Some countries have called for "compliance through technological design" to regulate AI. The European Union places a high value on the use of "regulatory sandbox" tools to encourage technical innovation through policy innovation while balancing innovation and regulation. Some nations have created a digital technology division within their antitrust watchdogs to monitor competition among digital platforms and enforce effective antitrust practices. Such practices are worth referencing.

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