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A Study on the Growth Drivers of Chinese Telecom Operators from the Perspective of Juglar Cycles: Focusing on the Period 2011-2021

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ABSTRACT
This paper adopts the perspective of Juglar cycle theory and focuses on the period from 2011 to 2021 to conduct an in-depth analysis of the growth drivers of China's three major telecom operators. By examining the cyclical fluctuations and underlying mechanisms of the telecom industry, it reveals the challenges and opportunities faced by telecom operators at different stages of the cycle and offers corresponding growth strategy recommendations. The research results indicate that, at the current stage, Chinese telecom operators should focus on areas such as technological innovation, market expansion, and risk management in order to achieve sustainable and high-quality development.

KEYWORDS
Juglar Cycle Theory; Telecom Operators; Growth Drivers; Technological Innovation; Market Expansion

The Juglar cycle theory posits that economic activity follows 9-10 year fluctuations driven by fixed capital renewal, as shifts in capital expenditure and equipment updates influence overall economic operations. While this theory captures macroeconomic trends, it also shapes micro-level business decisions. However, research on its impact at the industry level remains limited and primarily focuses on the real economy. For instance, Yin Zhujia examined its correlation with stock price fluctuations in China's equipment manufacturing sector [1], while Huang Junting explored its relationship with high-speed rail enterprise performance [2]. Similar cyclical patterns exist in the telecom industry, reflected in technological innovation, market demand shifts, and evolving competition. Yet, domestic studies on this sector remain scarce. This paper applies Juglar cycle theory to analyze the cyclical fluctuations in China's telecom industry from 2011 to 2021, identifying challenges and opportunities faced by the three major operators at different stages, examining their growth drivers, and proposing strategic recommendations.

1 Juglar Cycle Theory

The Juglar cycle theory, proposed by French economist Clément Juglar in 1862, describes 9–10 year economic fluctuations, commonly referred to as business cycles. It identifies three recurring phases—prosperity, crisis, and recession—forming cyclical economic patterns [3]. Long-term observation and data analysis enhance the ability to predict these cycles, and their stability makes the theory widely applicable. In the prosperity phase, economic activity peaks with strong investment and consumption; in the crisis phase, excessive investment and overcapacity disrupt market balance, reducing corporate profits; in the recession phase, economic activity declines, unemployment rises, and both investment and consumption weaken. Innovation, including new technologies, plays a key role in shaping economic cycles. Van Duijn argues that innovation drives cyclical fluctuations through four stages—adoption, growth, maturity, and decline—which correspond to economic phases: growth-prosperity, maturity-decline, recession-downturn, and recovery-adoption, forming an "innovation lifecycle" [4]. Kydland and Prescott suggest that real factors, particularly technological shocks, drive economic cycles, with rational economic agents adjusting labor supply and consumption in response to technological changes to achieve Pareto-optimal equilibrium [5].

China also experiences economic cycles, a consensus widely recognized in academia. From 2011 to 2021, China entered a new economic cycle, with growth slowing due to industrial restructuring. Economic momentum gradually shifted from high-pollution, high-energy industries to modern, technology-driven sectors led by digitalization. The Juglar cycle remains the primary driver of this transition, and the successful shift in long-term technological cycles provides crucial momentum for sustained economic growth. However, due to the lengthy process of technological evolution, the full release of growth potential still requires time [6].

The Juglar cycle reveals the underlying mechanisms of cyclical fluctuations in economic activity, closely linked to the input-output relationships of various industries. For the telecommunications industry, a thorough exploration of its development trajectory, impacts, transmission mechanisms, and spillover effects within the economic cycle is of significant importance for understanding and grasping the dynamic evolution of the sector. By systematically identifying and analyzing the performance of the telecommunications industry at different stages of an economic cycle, this approach provides telecom operators with scientific decision-making foundations. It can also offer tailored policy recommendations and development pathways to achieve high-quality growth. This not only contributes to the sustainable development of the telecommunications industry itself but also provides strong industry support and reference for the formulation and implementation of macroeconomic policies. This paper addresses several related issues:

(1) Observation Indicators

GDP growth, telecom revenue growth, and equipment investment cycles are key indicators for observing the Juglar cycle. These metrics provide quantitative tools for analyzing economic trends in the telecom sector. By comparing telecom revenue growth with GDP growth, one can assess the industry's contribution to economic expansion and its cyclical fluctuations. Equipment investment reflects technological upgrades, marking generational transitions such as the evolution from 2G to 5G. From 2011 to 2021, China's telecom operators advanced from 3G and 4G to intelligent 5G networks.

(2) Driving Factors

Equipment investment is a core driver of the Juglar cycle, reflecting the demand for technological advancements and equipment updates, which are key to understanding economic fluctuations. In the telecommunications industry, growth is driven by technological iteration and capital expenditure. Changes in capital expenditure signal shifts in technology and investment. Chinese telecom operators use the average useful life depreciation method, leading to rapid equipment iteration and periodic fluctuations in fixed asset investment. Additionally, societal demand for technology, influenced by personalized needs, drives both technological innovation and the allocation of funds, shaping market demand and technological progress through user base expansion and business structure changes.

(3) Relation to the Kitchin Cycle

American economist Joseph Kitchin proposed the Kitchin cycle, suggesting that economic development experiences regular fluctuations every 40 months, primarily driven by changes in business inventories, which describe short-term fluctuations in commercial and economic activities. Schumpeter's theory of economic cycles posits that economic activity is characterized by long, medium, and short waves, with technological innovation being the fundamental cause of cyclical fluctuations. He introduced the "three-cycle nesting" model, where one Juglar cycle typically encompasses three Kitchin cycles [7]. The short-term fluctuations of the Kitchin cycle can corroborate the medium-term fluctuations of the Juglar cycle, providing high-frequency data support for the Juglar cycle and offering a more comprehensive understanding and prediction of economic fluctuations. In the telecommunications industry, products are primarily service-based, with few physical products; however, changes in telecommunications business volume can indirectly reflect inventory changes.

(4) Application in Formulating Growth Strategies

The Juglar cycle theory provides a key framework for understanding and predicting economic fluctuations, aiding policymakers in decision-making. In the telecommunications industry, managers and analysts can forecast economic trends, adjust investment strategies, and manage risks. During periods of expansion, they can increase capital expenditure to enhance network coverage and service quality, while during recessions, they can reduce costs, implement targeted marketing strategies, and explore new growth opportunities.

(5) Impact of Digital Technologies

Digital technology represents information in bits, and digital economy research examines whether and how digital technology transforms economic activities. Understanding its impact does not require overturning traditional economic theories but rather analyzing how economic activities change when information is represented in bits instead of atoms [8]. In 1965, Intel co-founder Gordon Moore proposed Moore's Law, stating that the number of transistors on a semiconductor chip doubles every 18 months. Alongside Gilder's Law, Metcalfe's Principle, and the Matthew Effect, this shaped the operational framework of the internet era [9], challenging traditional investment- and equipment-driven economic cycles. Digital technology innovation is a key driver of high-quality digital economic growth [10]. In the digital economy, the share of new technologies and services continues to rise, diverging from traditional equipment investment cycles and exhibiting more complex fluctuations. Challenges include variations in cycle length, intricate driving factors, digitalization impacts, and shifts in economic structures.

2 Development of China's Telecommunications Industry (2011-2021)

By the 2020s, societal progress can be defined by three stages in communication technology: 2000-2010, characterized by 2G services in the internet era; 2011-2020, defined by 3G and 4G services in the mobile internet era; and from 2021, transitioning into the digital intelligence era with 5G and AI. Mobile and broadband technologies have been foundational, with China's telecom evolution summarized as: 2G lagging, 3G breakthrough, 4G synchronization, and 5G leadership. The 2011-2021 period, as a complete Juglar cycle, aligns with China's 3G and 5G milestones.

In 2000, China Telecom Group Corporation (hereinafter referred to as China Telecom) and China Mobile Communications Group Corporation (hereinafter referred to as China Mobile) were established, alongside China United Telecommunications Corporation (hereinafter referred to as China Unicom), which had been founded earlier. This marked the formal start of the market-oriented operations of China's telecommunications companies, laying the foundation for the competition among the three major telecom operators. The three major telecom operators are the main entities in China's telecommunications industry, and they are the focus of this analysis. According to statistics from the MIIT (Ministry of Industry and Information Technology), by the end of 2010, the number of mobile phone users in China had reached 859 million, broadband users had reached 126 million, and the total number of internet users had reached 457 million. After ten years of development, in 2011, China's telecommunications industry entered the mobile internet era, driven by 3G technology. The period from 2011 to 2021, with mobile services as the main focus, can be further subdivided into:

(1) 3G Era (2011-2013)

The three telecom operators simultaneously launched 3G network construction, with China Unicom taking the lead in investment, resulting in a greater number of base stations and superior network quality compared to China Mobile and China Telecom. During this period, the operators' growth was driven by the demographic dividend, with performance largely fueled by the increase in user numbers. The annual growth rate of mobile communication revenue across the industry reached 12%, becoming a key highlight. By the end of 2013, China Mobile showed underperformance, with its market share in mobile services dropping to 69% and its user share to 62%. China Unicom remained relatively stable, increasing its mobile market share to 18% and user share to 23%. China Telecom quickly captured market share, with its mobile market share reaching 13% and user share at 15%. In 2013, the State Council issued the "Broadband China" strategy and implementation plan, prompting operators to increase their investment. In December of the same year, the Ministry of Industry and Information Technology (MIIT) issued 4G TD-LTE licenses and lifted the asymmetric regulatory restrictions on China Mobile's broadband business, allowing China Mobile to officially enter the broadband communication market.

(2) 4G Era (2014-2019):

Lagging behind in the 3G era, China Mobile immediately began constructing 4G infrastructure after obtaining its 4G license, building 720,000 base stations in 2014. China Unicom and China Telecom, which received their licenses in 2015, fell behind in construction. In 2014, the three operators jointly established China Tower Corporation Limited, achieving base station sharing to accelerate construction while reducing costs.

During this period, the growth of operators still relied on population dividends, but at a slower pace compared to the 3G era. Mobile service penetration rose from 91% in 2013 to 115% in 2019, while the average revenue per user (ARPU) declined from 61 yuan in 2013 to 47 yuan in 2019. As a result, the compound annual growth rate of mobile service revenue fell to -2% during 2013-2015 and 2018-2019. By 2019, China Telecom's mobile user base surpassed China Unicom's, with user shares at 20.9% and 20%, respectively.

In 2015, the General Office of the State Council issued the "Guiding Opinions on Accelerating High-Speed Broadband Network Development to Promote Network Speed Upgrades and Fee Reductions" (《关于加快高速宽带网络建设推进网络提速降费的指导意见》), outlining broadband development goals for 2020. All three operators accelerated broadband investments. New broadband market entrant China Mobile began expanding aggressively in 2015, acquiring fixed-line assets from China Tietong Telecommunications Corporation for 31.88 billion yuan. By 2016, China Mobile's broadband user base had surpassed China Unicom's, and in 2018, it exceeded 147 million users, overtaking China Telecom.

(3) 5G Era (From 2020):

In February 2020, the government held a meeting to accelerate the development and construction of 5G networks. All three major operators began building 5G base stations. China Mobile's 5G-related investment in 2020 reached 105 billion yuan, 3.4 times that of 2019, while the combined investment of China Unicom and China Telecom totaled 80.3 billion yuan, 3.7 times higher than the previous year.

According to the Ministry of Industry and Information Technology (MIIT), 580,000 new 5G base stations were added in 2020, with 330,000 built jointly by China Unicom and China Telecom. By the end of 2020, China had a total of 718,000 5G base stations, including 350,000 built by China Mobile and 368,000 jointly by Unicom and Telecom. In 2021, the three operators invested 184.9 billion yuan in 5G, constructing 650,000 new base stations.

In broadband construction, fiber-optic networks covered all cities at the prefecture level, with over 1 billion fiber-optic ports. Nine rounds of universal telecom services were implemented, enabling fiber-optic network access in 130,000 administrative villages. The broadband coverage rate in administrative villages, impoverished villages, and deeply impoverished areas ("Three Regions and Three Prefectures") increased from less than 70%, 62%, and 26%, respectively, to 100%, achieving full broadband access for all administrative villages.

3 Analysis of Growth Drivers from the Perspective of Juglar Cycle Theory

As a technology-intensive industry, the telecommunications sector also exhibits cyclical fluctuations. From 2011 to 2021, China's telecommunications industry experienced significant characteristics of a Juglar cycle. This cycle, driven primarily by technological innovation and shifting market demands, had a profound impact on the sector's development. Its key features are as follows:

(1) Technology-driven Cyclical Fluctuations

Technological innovation is the core driver of growth in the telecommunications industry. As mentioned earlier, from 2011 to 2021, China's telecommunications industry underwent a technological innovation cycle from 3G to 5G. Operators continuously increased Research and Development (R&D) investments, expanded network coverage and service quality, and grew their customer base to improve performance. The introduction of 3G popularized mobile internet, 4G boosted the proliferation of mobile internet applications, and 5G ushered in the era of the Internet of Things (IoT). As illustrated in Figures 3.1, 3.2, and 3.3, the investment data fluctuation exhibits several characteristics:

First, with technological upgrades, the scale of investments continually expanded. Investment in 3G increased by 290.66 billion yuan compared to 2G, and investment in 4G grew by 355.08 billion yuan compared to 3G.

Second, the peak of investments corresponds to 2012 in the 3G era and 2015 in the 4G era, while the investment troughs occurred in 2010 and 2018. The year 2020 marked the beginning of 5G, with operators preparing for significant investment. Overall, investment in 2020 increased by more than 22 billion yuan compared to 2019.

Third, with technological advancements, telecommunications operators consistently increased R&D investments in cycles. Technological innovation helped improve market share, enhance competitiveness, and improve corporate performance.

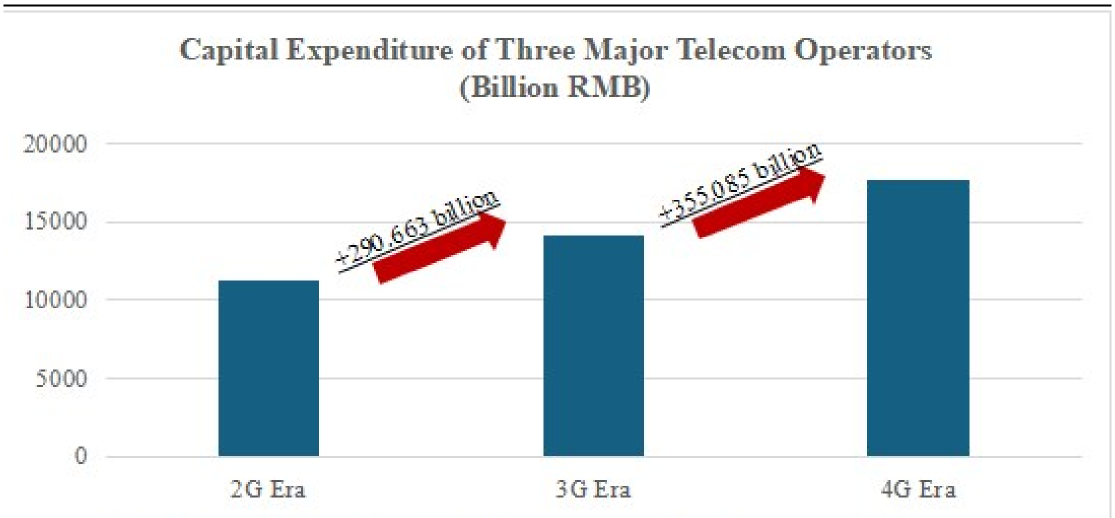

Figure 3. 1 Total Capital Expenditure of the Three Operators (Data Source: Annual Reports)

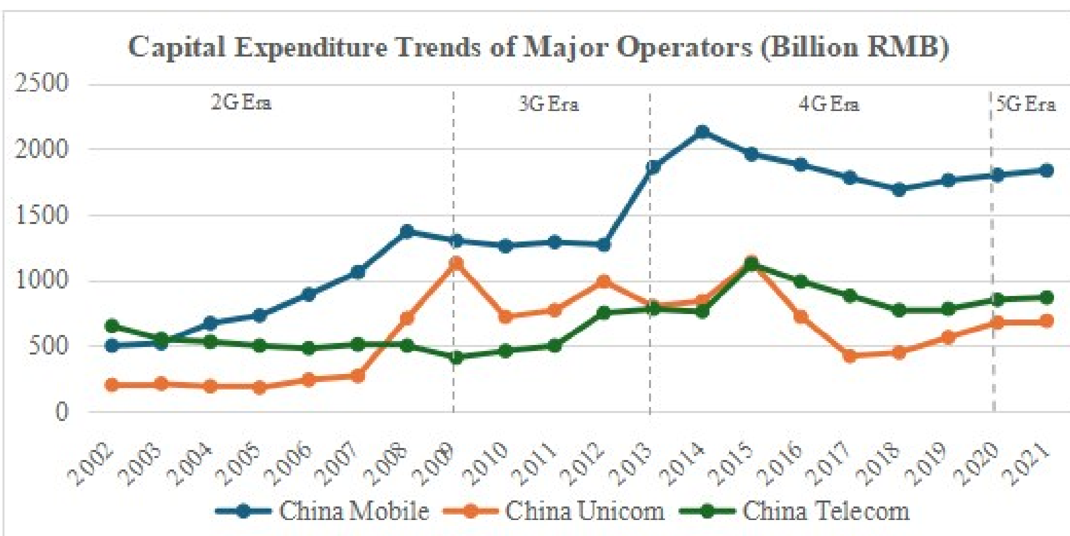

Figure 3. 2 Capital Expenditure Changes of Three Major Operators (Source: Annual Reports)

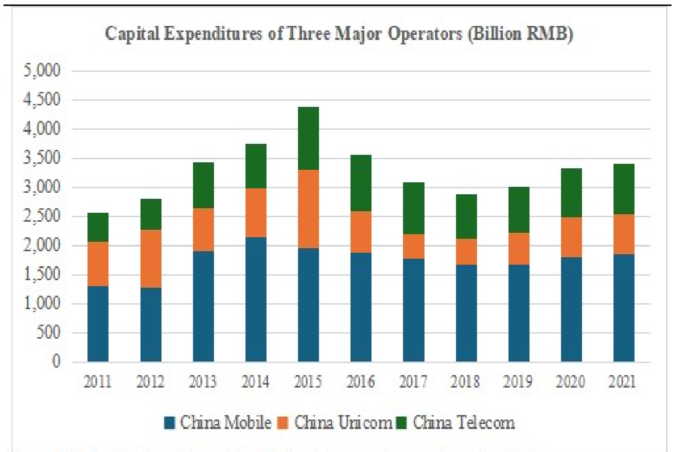

Figure 3. 3 Capital Expenditure of Three Major Operators (Source: Annual Reports)

(2) Cyclical Variations in Market Demand

Market demand fluctuations are a key driver of cyclical changes in the telecommunications industry. As shown in Figures 3.4 to 3.10, these changes have significantly influenced operators' performance. During the 2G era, growth transitioned from population dividends to investment-driven gains, with mobile user growth peaks in 2013–2015 and 2018–2020 corresponding to 3G and 4G investment surges. Broadband user growth followed similar patterns in 2015–2017 and 2018–2021. Rapid technology iteration reshaped market dynamics, enabling followers to narrow gaps and driving new investment. In China's oligopolistic telecom market, aggressive investment by followers spurred leaders to increase spending during subsequent technological cycles. By 2013, with mobile users exceeding the population, traditional services saturated, shifting demand toward digital and intelligent services. Operators expanded into household and enterprise markets, prioritized industrial digitalization, and integrated telecom with Information Technology (IT) and Information and Communication Technology (ICT). From 2013 to 2020, operators launched phased transformation strategies, accelerating digital transformation by 2018. This shift unlocked vast opportunities in fields like smart cities and telemedicine, with China Mobile leveraging its user base to maintain its competitive edge in digitalization.

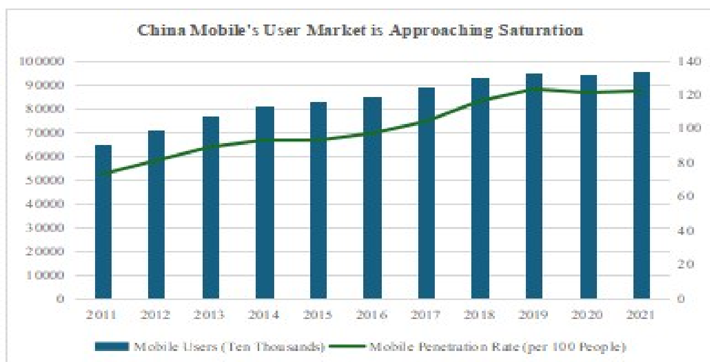

Figure 3. 4 China Mobile User Count and Penetration Rate (Source: Annual Reports)

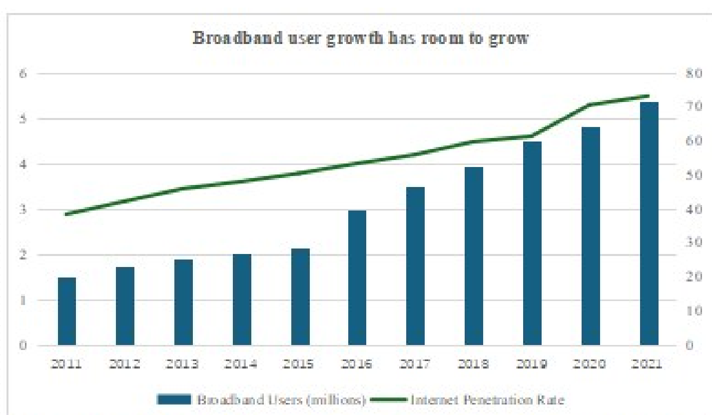

Figure 3. 5 Historical Broadband User Count and Internet Penetration Rate Changes (Source: Annual "China Internet Network Development Statistics Report")

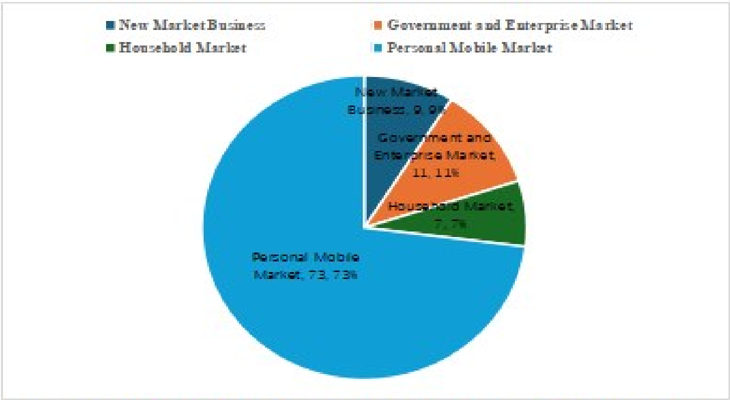

Figure 3. 6 China Mobile's 2018 Four-Wheel Drive Revenue (Source: China Mobile Annual Report)

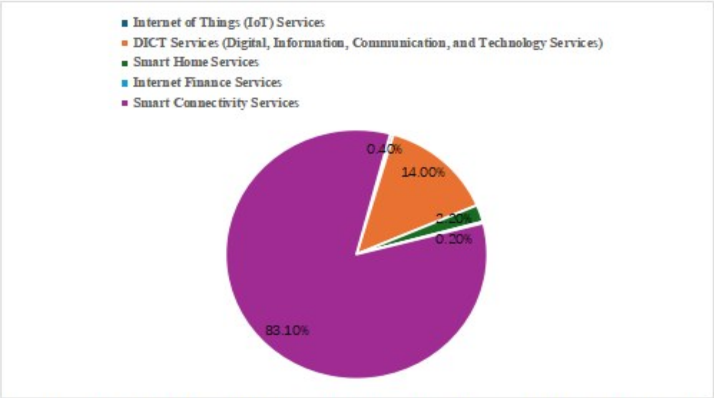

Figure 3. 7 China Telecom's 2018 Revenue Structure of Five Business Ecospheres (Source: China Telecom Annual Report)

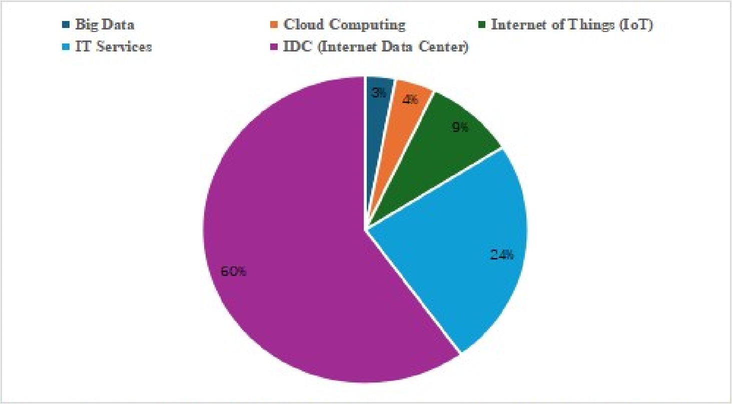

Figure 3. 8 China Unicom's 2018 Industrial Internet Revenue Composition (Source: China Unicom Annual Report)

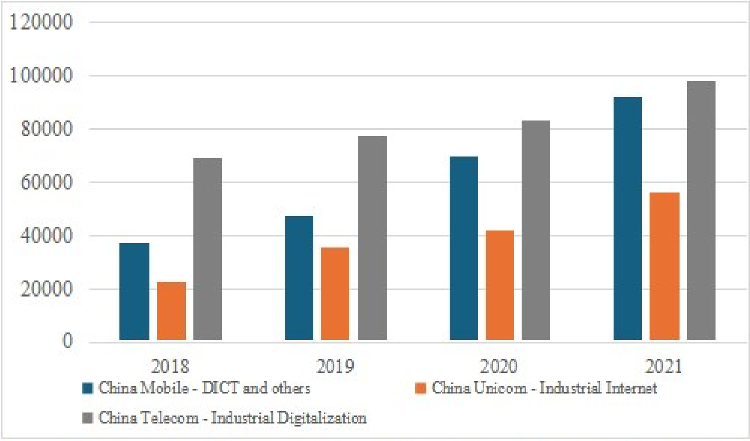

Figure 3. 9 Revenue from Digital Transformation Businesses of the Three Major Telecom Operators (Source: Annual Reports of the Companies)

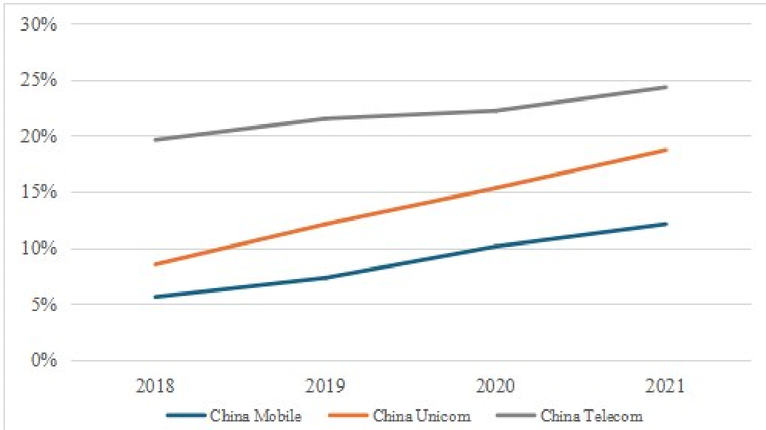

Figure 3. 10 Revenue Share of Digital Business of the Three Major Telecom Operators (Source: Annual Reports of the Companies)

（3）The Cyclical Evolution of the Competitive Landscape

With the evolution of new technologies and markets, the competitive landscape of the telecommunications industry undergoes cyclical changes, presenting new challenges and opportunities. As shown in Figures 3.11, 3.12, 3.14, and 3.15: First, after China Telecom entered the mobile business in 2008 and China Mobile entered the broadband business in 2015, ARPU for these services accelerated a long-term decline. However, mobile business ARPU experienced cyclical growth between 2012-2014, 2016-2018, and 2019-2021 due to technological upgrades. Second, market followers benefit from technological upgrades, with market share growing rapidly during the early adoption phase. For example, in 2018, China Mobile's broadband market share grew quickly. But as market leaders adopt the same strategies, competition becomes more homogenized, and ARPU declines, with leaders strengthening their positions through the Matthew effect.

In conclusion, technological innovation, market demand changes, and competition are the main drivers of cyclical fluctuations in the telecommunications industry. Analyzing these factors helps in understanding the growth mechanism and formulating effective investment strategies.

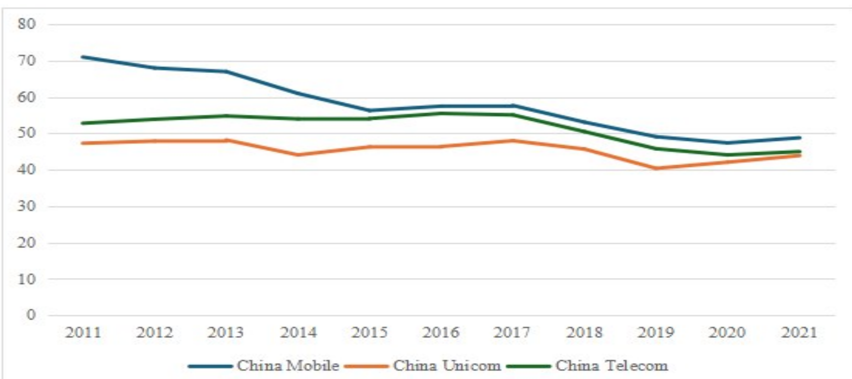

Figure 3. 11 Mobile ARPU of the Three Major Telecom Operators (Source: Annual Reports of the Companies)

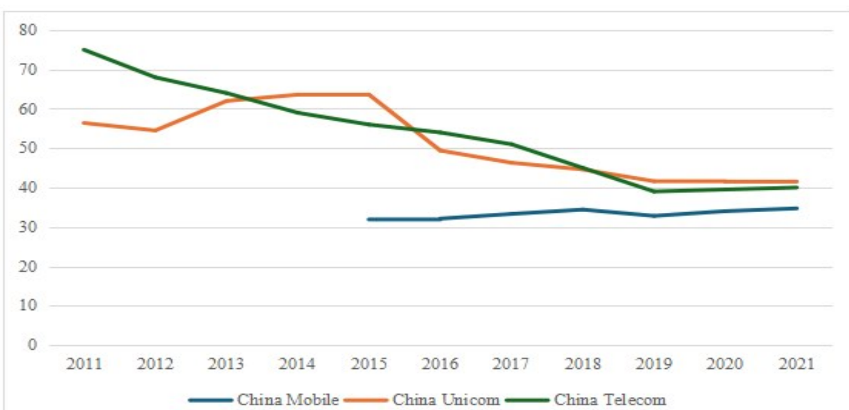

Figure 3. 12 Broadband ARPU of the Three Major Telecom Operators (Source: Annual Reports of the Companies)

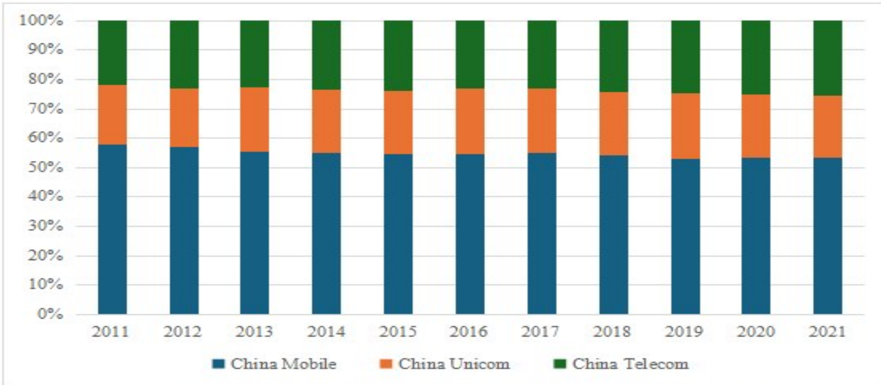

Figure 3. 13 Market Share of Main Business Revenue of the Three Major Operators (Source: Annual Reports of the Companies)

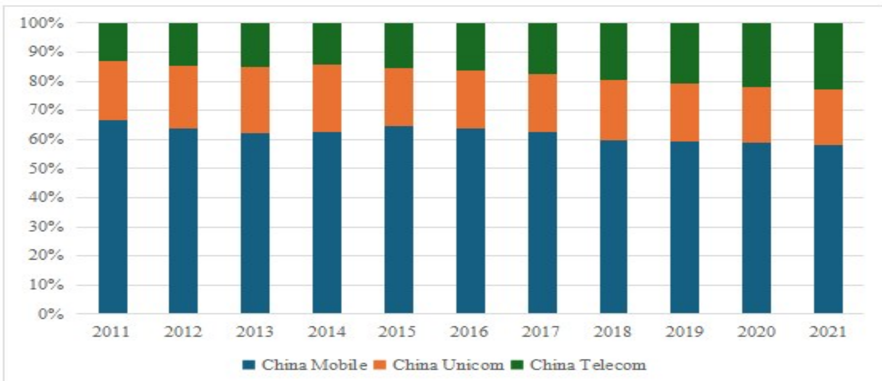

Figure 3. 14 Market Share of Mobile Business Users of the Three Major Operators (Source: Annual Reports of the Companies)

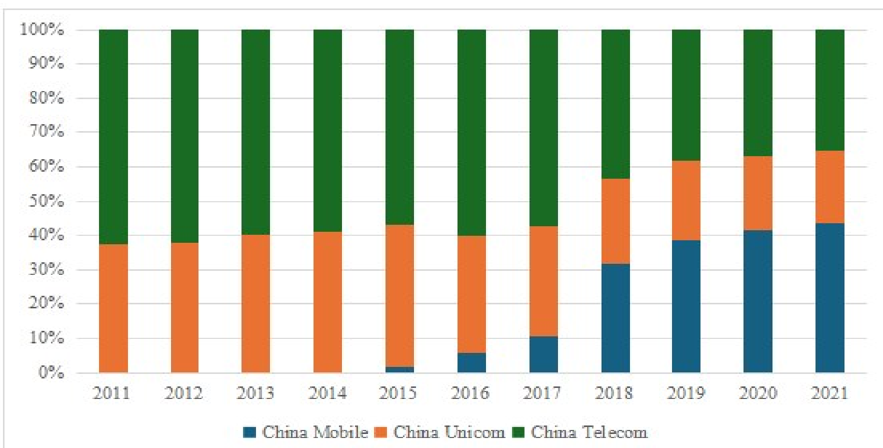

Figure 3. 15 Market Share of Broadband Access Business Revenue of the Three Major Operators (Source: Annual Reports of the Companies)

4 Growth Strategy Recommendations from the Perspective of the Juglar Cycle Theory

Based on the Kitchin cycle theory and the evolution of the telecommunications industry from 2011 to 2021, as shown in Figure 4.1: First, the telecommunications industry followed a Kitchin cycle aligned with macroeconomic fluctuations, with clear industry-specific characteristics driven by technological innovation, resulting in three complete cycles. Second, the industry's three peaks corresponded to the 3G, 4G, and 5G investment and technological upgrades, with the broadband fiber-optic upgrade cycle overlaying these. Operators adopted strategies that aligned with these peaks: during 3G, expanding user base and focusing on individual users; during 4G, optimizing internal mechanisms and integrating mobile and broadband services for family users; and during 5G, accelerating digital transformation and targeting government and enterprise users. Third, there were three troughs corresponding to these peaks, during which operators focused on maintaining existing business models and innovating, while also reserving new technologies and investments. The cyclical nature of technology and market strategies led to repeated business downturns.

Based on the above analysis, the following targeted growth strategy recommendations are proposed:

(1) Grasping the cycle fluctuation patterns: Telecom operators should study industry trends, focus on long-term development, and accurately understand the industry's cyclical fluctuations to formulate strategic plans. In terms of investment, the telecom industry's driving force mainly relies on technological iteration and capital expenditure. Therefore, operators should actively leverage technological opportunities, identify industry cycles, and make precise investments to meet market demands and support sustainable development. Market strategies should align with investment cycles, embracing differentiated competition and turning investment dividends into development advantages. Particularly, market followers should quickly adopt new technologies, innovate business models, and utilize next-generation technologies like AI to drive digital and intelligent transformation, seizing market opportunities during each technological iteration. Operators should also engage in counter-cyclical adjustments, optimizing investment intensity and market opportunities, introducing timely policies to shorten downturn periods and mitigate cyclical fluctuations.

(2) Strengthening technological innovation and R&D: Telecom operators should continuously increase R&D investment, recognizing the critical role of technology in the digital era and its decisive driving force in cyclical development. Operators must abandon the pipeline mindset and position themselves as technology-driven companies. They should accelerate traditional network upgrades and invest in new information infrastructure, keeping pace with trends in intelligent, digital, and integrated technologies. This includes software-defined networks, cloud-network convergence, and integrated computing-network upgrades, reinforcing operators' foundational role in the digital age. Building a technological innovation system, cultivating talent, and enhancing R&D capabilities are crucial, particularly in cloud computing, computing power, AI, and cybersecurity. Operators should also focus on establishing innovation partnerships, leveraging industry chain leadership, and collaborating with enterprises, universities, and research institutions for joint R&D and technology commercialization. Establishing specialized companies in key areas, such as China Telecom's focus on Tianyi Cloud, AI, security, quantum communication, and low-altitude economy, while accelerating new technology development through strategic investments and acquisitions, is essential for strengthening technological growth and positioning.

(3) Expanding the market: Telecom operators should adopt flexible, proactive strategies to meet market demands, focusing on new products and services. During downturns, leverage big data and AI for customized offerings, and simplify product packages to improve marketing success. Strengthen brand strategies and build customer loyalty. In upcycles, research emerging fields like AI, smart cities, and industrial IoT, while expanding into government and enterprise sectors. Foster cross-industry collaboration and explore new business areas. Respond to the Belt and Road initiative by leveraging domestic and international resources to grow both local and overseas markets, boosting development with new momentum.

(4) Enhancing the risk management system: Telecom operators should establish a risk early warning mechanism to proactively address issues such as profit decline, rising costs, and sluggish growth caused by cyclical downturns, thereby improving risk resilience and ensuring steady development. In terms of policy risk, operators should continuously monitor macro-policy changes and adjust business strategies in a timely manner to ensure sustainable development. From a management perspective, optimizing cost control and internal management, promoting digital transformation, and enhancing business processes and decision-making intelligence are essential. In terms of investment, operators should control capital expenditure, reduce network construction, marketing, and operational costs, ensuring the release of cash flow for future needs.

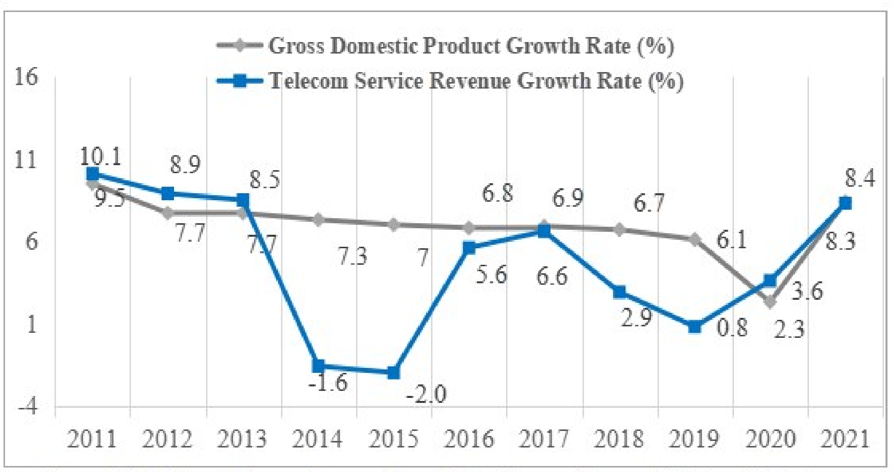

Figure 4. 1 GDP and Telecom Revenue Growth Rate Changes (Source: Ministry of Industry

5 Conclusion

This paper, from the perspective of the Juglar Cycle theory, analyzes the growth drivers of Chinese telecom operators during the period from 2011 to 2021. It systematically reveals the cyclical fluctuations and underlying mechanisms of the telecom industry, examining the industry's development trajectory, challenges, and opportunities. Based on these insights, the paper proposes targeted growth strategies to help telecom operators better navigate industry cycles and seize market opportunities. These strategies focus on technological innovation, market expansion, business model transformation, and risk management to enhance operators' core competitiveness and market position. Looking forward, with the continuous advancement of technologies like artificial intelligence and the ongoing changes in market demand, Chinese telecom operators will face a more complex and dynamic market environment. Therefore, operators need to constantly innovate and refine their development strategies, stay aligned with technological trends, and meet diversified user needs to achieve sustainable growth.

About the Author

Jia'an Dong, a high school student. Research interests include economic anthropology, digital economy, and internet finance.

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