AI-Enabled Industrial Innovation in the Low-Altitude Economy: Logical Mechanisms and Practical Pathways

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Abstract

The low-altitude economy is a strategic requirement in China. However, its high quality development encounters some institutional lag and shortage of intelligent infrastructure. The paper discusses how artificial intelligence (AI), a general-purpose technology, promotes the industrial innovation of low-altitude economy by integrated logical, feasible path. Based on context driven innovation theory, industrial innovation ecosystem theory, Pasteur's quadrant theory and new whole-of-nation system theory, we develop a framework of three logical channels-technology empowerment, scenario driving and industrial upgrading-to summarize the intrinsic relationship between AI and low-altitude economic development.Our exploration discovered the three inter-weaving drivers: a value logic through which AI brings about multi-level high-quality development (micro-level factor upgrading, meso-level industrial ecology evolution, and macro-level growth pattern change); an operation logic rooted in scenario-driven digital intelligent empowerment, where specific application requirements drive technological selection and technology capability, data capability and intelligent processing capability; and a realization logic that involves some major technologies (5G/6G communications, AI path making) and supportive institutional environments. Following these findings, we give four practical pathways-scenario driving innovative development, data value transmitting, intelligent infrastructure raising and industrial ecology synergy-and the explicit policy advice for practical actions include airspace management reform, enduring investment of low-altitude equipment and communication, navigation and surveillance facilities and techniques, air-traffic management modernization, and expanded application cross-field scenarios. Contributing to the literature, our study provides a detailed theoretical understanding about AI-enabled industrial transformation in the emerging economic areas, which can serve China's large-scale high-quality, leapfrog from regional pilots to the development of the low-altitude economy.

Keywords

Low-altitude economy, artificial intelligence, industrial innovation, scenario-driven innovation, intelligent infrastructure.

1. Introduction

As a paradigm of new quality productive forces and the new emerging strategic industries, the low-altitude economy is an important breakthrough for building new economic growth points and new pillar industries[1]. In 2025, National Development and Reform Commission established a low-altitude economy development Department, and all 31 provinces and

provinces across China rapidly speed up strategic layout, which means that low-altitude economy has been raised up to a national strategic height[2]. But the high-quality development of low-altitude economy still face bottlenecks, such as slow advancement of institutional innovation and lacking intelligent infrastructure support.

Current study has summarized the research journey of the connection between the low-altitude economy and economic growth in three phases: foundation period based on the general aviation, exploratory period based on policy directional factor agglomeration, and activation period mainly based on intensive utilization of airspace resources. Current research has unfolded from three aspects. First, on the logic and growth logic, academics' views generally hold that the low-altitude economy promotes high-quality development by reshaping production factors, changing the cost mechanism and perfecting market mechanism. Second, in terms of technology–industry combination mechanisms, research focused on theory and the path of "science-industry combination." Third, in terms of industrial ecosystem creation and regional practice, research focuses on the international practice and policy system. Plenty of results exist, but the deficiencies are also obvious.

Majority of the studies studied are rather unidimensional, focusing either on core technology R&D, application scenario implementation or policy and regulation optimization, systematic research on how to deeply connect technological innovation and industrial innovation so that industrial innovation can be promoted into high quality is very scarce[3]. Particularly with respect to artificial intelligence empowerment, most of existing research are still staying at the level of application or technical application, have inadequate theoretical explanation and structural analysis regarding how AI, as a GPT, can be deeply embedded into and fundamentally reform the theoretical principles, driving logic and systematic road of low-altitude economy.

Against this background, the deep empowerment of artificial intelligence has both practical demands and theoretical demands. As a general technology, AI is the engine to address challenges of flight safety and operational efficiency of low altitude flights, industry changes and innovative business models entirely. This paper is intended to systematically analyze the development logic and practical paths in which artificial intelligence empowers the low-altitude economy, and provide references and decision makers' theoretical support for gradually converting from "scale development" to "Advance quantity and quality in tandem".

2. Theoretical Foundations and Analytical Framework

2.1. Core Concept Definition

Low-altitude economy refers to industrial activities using low-altitude airspace resources, aerial carriers, such as unmanned aircraft (UAV), electric vertical take-off and landing (eVTOL) aircraft, and subject to a variety of innovative technologies [4]. They are implemented in a vertical altitude range of less than 1,000 m of the ground level (up to 3,000 m according to the regional characteristics and practical demand), covering logistics delivery, cultivation surveys, emergency duty, culture tourism and other low-altitude air-space used fields, which is a special industry with characteristic of "to fly in the air, to bring impact to the ground", and the connotation and expansion of artificial intelligence empowering.

2.2. Theoretical Foundations

(1) Context-driven innovation theory. The context-driven innovation theory emphasizes application scenarios as carriers and mission needs or strategic needs as guidance, to support organic integration, innovative use and iterative upgrade of core factors including technology, market, data, product, etc.[5]. This theory provides the main analysis view on how AI integrates into all kinds of scenarios of low-altitude economy.

(2) Industrial innovation ecosystem theory. Industrial innovation ecosystem constitutes value networks in which various innovation actors integrate around the same goal, organically iterates by dynamically interacting with outside world, and maintaining an innovation momentum.

(3) Pasteur's quadrant theory and science-industry integration theory. The characteristic of the Pasteur's quadrant is demand-oriented basic research guided by industrial application, revealing the operational logic for deep integration between technological innovation and industrial innovation.

(4) New whole-of-nation system theory. The main feature of the new whole-of-nation system is organically joining governmental mechanisms of resource coordination and market mechanisms of resource allocation through institutional innovation, and consolidating the collaborative research strength in whole industries, academia and applications.

2.3. Analytical Framework Construction

A three-dimensional analytical framework-"technology empowerment–scenario driving–industrial upgrading"-is constructed to examine AI-empowered industrial innovation development in the low-altitude economy. The low-altitude economy represents a quintessential "technology-intensive + cross-industry" economic form. Technological innovation establishes the technical foundation for resolving challenges in flight safety, operational efficiency, and scenario adaptability, while industrial innovation provides implementation scenarios and developmental momentum. Their deep integration generates endogenous driving forces for quality-quantity synergy. The essence of AI empowerment in the low-altitude economy lies precisely in the intelligent upgrading of this integration process.

3. Logical Mechanisms of AI Empowerment in the Low-Altitude Economy

3.1. Value Logic: Multi-dimensional Mechanisms of High-Quality Development

Low-altitude economy uses the triple assets of making industry, public goods and commodities. The low-altitude economy, exploiting the triple assets of making industry, public goods and commodities, is speeding up the birth of a new economic type with a market value of over a trillion yuan, and it is becoming a new engine of high-quality economic growth. At the micro level, by airspace factor upgrading, structural cost reform, spatio-temporal constraint opening up and airspace factor optimization, 'growth momentum transformation' is formed between low-altitude market players; At the meso level, by horizontal and vertical industry connections, industrial innovation ecosystem model formation, industrial structure improvement, cross-industry industrial integration, high-quality industrial development is promoted through dynamic change of low-altitude industry itself; At the macro level, by breaking traditional growth boundaries, frontage production technology lines, forming collaborative innovation ecosystem, the pattern of economic growth is reshaped through growth momentum transformation induced by airspace factor. Artificial intelligence, as a general-purpose technology, plays a critical empowering role across all the aforementioned multi-level mechanisms.

3.2. Operational Logic: Core Mechanisms of Scenario-Driven Digital-Intelligent Empowerment

Based on the CDAE theoretical model, this study explores the working mechanism of AI empowerment in the low-altitude economy. The model mainly bases scenario drive on the core of analysis, and the explicit application scenario requirement drives the choice of technology, data, institution and other elements. To be explicit: first, context-driven exploration breaks traditional industrial blocks, integrates and forms new business forms (such as “low-altitude + agriculture”, “low-altitude + inspection”, “low-altitude + cultural tourism”, “low-altitude +

logistics", "low-altitude + disaster relief" and so on), and conducts "low-altitude, controlled and open management of airspace resources" digitally; second, high-quality industrial data serves as training for AI algorithms—the development of the low-altitude economy relies on multi-type, high-precision data, and building up comprehensive, high-quality datasets is necessary for intelligent, scalable development. Third, intelligent technologies (AI) are the mainstream driving force that can efficiently process the massive real-time data from UAVs, low altitude aircraft, ground sensors and management control system information to realize detailed perception of the low-altitude space and real-time judgment, risk identification, situational analysis and real-time decision making. Fourth, these parties all work in the low-altitude economy ecosystem, achieving ecological integration of different scenarios. Simultaneously, the dynamic circular activity mechanism of science-industry convergence is another operational logic component. Demand-pull mechanism, supply-push mechanism, factor-circulation mechanism and collaborative-iteration mechanism form the circular process of demand-pulling, technology pushing, factor flowing and iterative optimization for technology innovation and industrial innovation, promoting the synchronized resonance and mutual effect among them.

3.3. Realization Logic: The Supporting Role of Key Technologies and Institutional Environments

AI empowerment of the low-altitude economy also depends on breakthroughs in core technologies and evolution of its institutional environment. Digital-intelligent technology breakthrough can stimulate AI level upgrades for the low-altitude economy: the extensive coverage of 5G communication technology and the breakthrough application of 6G technology provides high-speed, low-delay information transmission capabilities between low-altitude flight equipment and ground control centre to meet complex application scenarios, such as the coordinated flights of multiple aircraft. Breakthrough in AI path planning technology can adapt to various data, such as instantaneous traffic situation and navigation restriction, to dynamically generate best flight plans, improving aircraft flight efficiency and safety. Deep integration of technological innovation and industrial innovation takes effect of mutual empowerment, combination of entire chain and factors linkage, closely conforming to the intrinsic logic of the"techno-economic paradigm"of low-altitude economic development.

4. Practical Pathways and Policy Recommendations for AI-Enabled Industrial Innovation in the Low-Altitude Economy

4.1. Practical Pathways

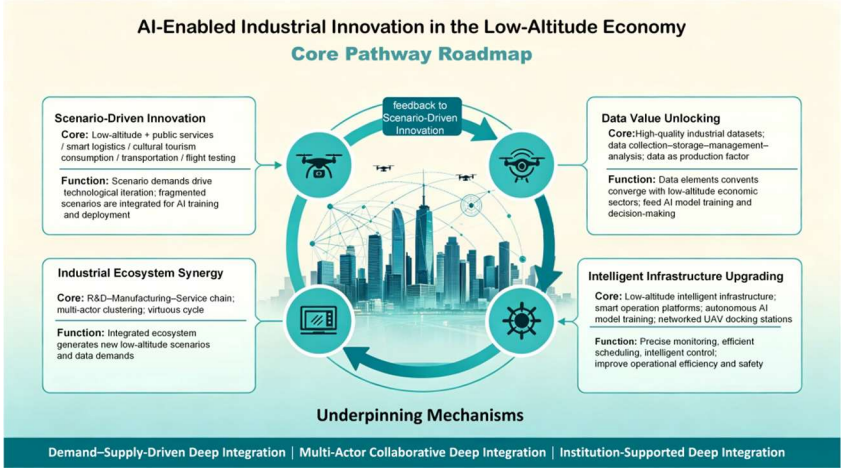


Figure 1. Core Pathway Roadmap of AI-Enabled Industrial Innovation in the Low-Altitude Economy

The Core Pathway Roadmap of AI-Enabled Industrial Innovation in the Low-Altitude Economy is shown as Figure 1.

(1) Scenario innovative development. The market demand is the guidance of"market demand", possible application scenarios of the low-altitude economy need to be explored systematically, and multiscale scenarios (such as "low-altitude + public services", "low-altitude + smart logistics", "low-altitude + cultural tourism consumption", "low-altitude + transportation", "low-altitude + flight testing", etc.) ecosystem needs to be built. This will motivate the process of for feedback in which"scenario demand"drives"technological iteration"and"technological innovation"leads"scenario upgrade". The organized integration of scattered scenarios serves the necessary conditions for training and deploying the AI model.

(2) Unseating data value. Developing high-quality industrial datasets elevates both the safety and innovativeness of the low-altitude economy and boosts the amplification effect of data as an input factor. Integration of data resources in all industries in the low-altitude industrial chain and enhancement of data collection, storage, preservation, processing capabilities facilitate the deep integration of data elements with other elements of the low-altitude economy.

(3) Intelligence equipment upgrading. Increased investment in low-altitude intelligent equipment enables precise management, accurate scheduling and intelligent operation of low-altitude flights, improving the operation efficiency and safety. An intelligent operation and control system can be set up with smart operation platform, autonomous learning of AI system and network UAV docking station of the region.

(4) Industrial ecosystem synergy. Seeking integrated development of the low-altitude industrial ecosystem should establish an entire"R&D-manufacturing-service"chain as a virtuous cycle for clumping up of the various actors and factors. Three mechanisms of technological-industrial integration: demand-driven supply-driven deep industrial integration, multiactor collaborative deep industrial integration, institutional-boosted deep industrial integration, jointly consolidate these development pathways.

4.2. Policy Recommendations

(1) Strengthen policy innovation and institutional safeguards. Reforming the airspace management system should be accelerated to establish a scientific, stable, and efficient mechanism, streamline enterprise route approval procedures, and reduce compliance costs[6]. Data governance norms for the low-altitude industry need to be developed and refined to promote data sharing and activate the potential of data as a production factor.

(2) Emphasize technological innovation and infrastructure development. Sustained investment is required in key technologies such as low-altitude equipment, communication and navigation, and operational control systems. The construction of low-altitude intelligent infrastructure, including communication networks, high-precision navigation systems, and intelligent sensing devices, should be accelerated.

(3) Reinforce scenario-driven development and industrial ecosystem building. Deeper integration between the low-altitude economy and agriculture, industry, and services should be pursued to expand application scenarios. Collaborative efforts involving industry, academia, research, and application should be encouraged to explore diversified models in emerging fields such as “low-altitude + education,” “low-altitude + healthcare,” and “low-altitude + security.” Furthermore, the advantages of the new whole-of-nation system should be fully leveraged, with core scenario demands as the guiding objective and a highly efficient collaborative innovation system as the vehicle, to advance the deep integration of low-altitude technological innovation and industrial innovation.

5. Conclusion

AI-enabled innovative development of the low-altitude economy is a systemic effort orientated to scenarios, anchored to data element base, driven by intelligent technologies, and carried on the industrial carrier. AI is not only a tool to improve efficiency in various parts of the low-altitude economy, but also a core engine driving transformations of industrial forms and actively generating innovative models and business ecosystem services for low-altitude economy, assisting the economy enter the era of intelligence. Deep fusion of technology and industry innovation in different levels-(technology + scenarios), innovation chain + industrial chain, digital intelligence + industry, regions + industries-allow integration advantages turning into effective industrial development performance. The 15th Five-Year Plan period is the key stage for China's low-altitude economy moving from regional pilot form to mass high-quality form.

Future studies could also look into different integration channels between eastern, central and western China, and study how frontier technology, such as large AI models, digital twin, further changes technological–industrial integration in different scenarios, to enrich the research on AI's empowering roles and mechanisms for low-altitude economy. In addition, due to the constantly emerging new business models and new application scenarios, there is a need for sustained attention to the interaction between AI technological iteration and low-altitude industrial evolution. Promp responses to new demands from airspace safety regulation and data governance entailed by new technology applications will provide scholars' theoretical assumptions and suggestions for improving institutional rules and policies and ultimately helps low-altitude economy in China to achieve a healthy and long-run development.

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