

Research on AI-Empowered Value Co-creation and Governance Mechanisms in Regional Innovation Ecosystems

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Abstract: With the deep penetration of artificial intelligence (AI) technology, regional innovation ecosystems are undergoing profound transformation. AI reshapes these ecosystems through four pathways-knowledge empowerment, optimized resource allocation, collaborative innovation promotion, and intelligent risk management-exhibiting four evolutionary characteristics: intelligence, platformization, openness, and adaptability. This forms a value co-creation cycle of “perception-matching-collaboration-evolution”. This study proposes a four-dimensional governance framework encompassing multi-stakeholder collaborative governance, data circulation mechanisms, intelligent regulatory systems, and dynamic incentive mechanisms. It provides theoretical guidance and practical pathways for governments to formulate regional innovation policies, enterprises to participate in ecosystem construction, and the deep integration of the digital and real economies. This research holds significant implications for enhancing regional innovation capabilities and building a modern industrial system.

Keywords: artificial intelligence; regional innovation ecosystem; value co-creation; governance mechanism

1. Introduction

Against the backdrop of a new wave of technological revolution and industrial transformation, artificial intelligence-as a strategic technology shaping the future-is profoundly altering the organizational structures, collaborative models, and value creation logic of regional innovation. In August 2025, the State Council issued the “Opinions on Deepening the Implementation of the AI+ Initiative”, explicitly calling for the deep integration of AI across all economic and social sectors. This initiative aims to reshape production and living paradigms, accelerating the formation of a new intelligent economy and society characterized by human-machine collaboration, cross-boundary integration, and co-creation and sharing. This underscores AI’s pivotal role as a national strategic scientific force and charts the course for the transformation and upgrading of regional innovation ecosystems. However, alongside the rapid advancement of AI technology, regional innovation ecosystems face practical challenges such as insufficient coordination among key players, inefficient resource allocation, restricted flow of innovation factors, and outdated governance mechanisms. Consequently, how regional innovation ecosystems can adapt to AI-driven transformations and achieve value co-creation among diverse stakeholders through effective governance mechanisms has become a pressing frontier issue in both

theory and practice.

Existing research primarily focuses on value co-creation mechanisms within traditional innovation ecosystems, with limited systematic exploration into how AI technologies reshape the underlying logic of regional innovation ecosystems, the pathways for realizing value co-creation, and corresponding governance mechanisms. Traditional innovation ecosystem theories emphasize interaction and symbiosis among diverse actors, but under AI empowerment, innovation actors, processes, and outcomes have undergone fundamental transformations. AI technology is not merely an innovation tool but has become a pivotal element connecting, empowering, and restructuring innovation ecosystems. Consequently, there is an urgent need to construct a theoretical framework for value co-creation and governance in regional innovation ecosystems that aligns with the characteristics of the intelligent era. This study seeks to address the following core questions: First, how does AI empower regional innovation ecosystems and reshape their value co-creation logic? Second, how can ecosystem governance mechanisms compatible with intelligent innovation be constructed? By answering these questions, this research aims to reveal the intrinsic mechanisms of AI-empowered regional innovation ecosystems, providing theoretical support and practical guidance for enhancing regional innovation capabilities and promoting high-quality development of the digital economy.

2. Theoretical Foundations and Literature Review

2.1. Overview of Artificial Intelligence Research

Conceptually, artificial intelligence (AI) is a frontier technology that aims to simulate human intelligence through computer systems to perform complex tasks including learning, reasoning, problem-solving, and language comprehension [1]. The concept of AI has continuously expanded, evolving from early rule-based automated systems to encompass a broad technological framework including machine learning, deep learning, and natural language processing. This evolution spans not only technical and algorithmic dimensions but also its extensive applications across society, economy, and industry, positioning AI as a core driver of modern technological transformation [2]. In terms of characteristic types, key features of AI include adaptability, autonomous learning capabilities, and intelligent decision support [3]. Classified by application scenarios and technological depth, AI narrowly refers to task-specific automation, while broadly encompasses systems with human-like intelligence, generative large models, and domain-specific applied AI (e.g., smart manufacturing) [4]. Regarding application impacts, AI serves as a vital tool for enhancing efficiency and optimizing decision-making. Its widespread adoption in industrial innovation, social governance, and public services has profound socioeconomic implications. Through big data analytics, IoT, and cloud computing, urban administrators can more precisely regulate resources in critical domains like transportation, energy, and public safety [5–7].

2.2. Review of Research on Regional Innovation Ecosystems

Conceptually, a regional innovation ecosystem refers to a complex network system within a specific region where multiple stakeholders—including governments, enterprises, research institutions, and the public—interact to collectively drive innovation. This system emphasizes the organic integration and synergy of innovation factors, with resources, knowledge, technology, policies, and other elements within the region working together to form an innovation ecosystem with distinct regional characteristics [8]. Regarding its operational mechanisms, the ecosystem manifests in three primary ways: First, it enhances the collaborative innovation capabilities of regional innovation actors by facilitating the flow of knowledge and technology, thereby boosting overall innovation efficiency. Second, through multi-stakeholder cooperation and interaction, the regional innovation ecosystem achieves optimal resource allocation, enhancing regional innovation effectiveness. Third, through policy guidance and institutional support, the regional innovation ecosystem fosters an innovation-friendly environment, stimulating the innovative vitality of enterprises and the public, thereby driving the sustainable development of the regional economy [9–11]. Key influencing factors include the policy environment, knowledge mobility, technological innovation capacity, and innovation culture. The quality of the policy environment directly impacts the allocation of innovation resources and the execution of innovation activities. Knowledge mobility determines the speed of technology diffusion among innovation actors.

Furthermore, the technological innovation capacity of enterprises and the level of support for innovation culture within the region significantly determine the overall vitality and sustainable development capability of the regional innovation ecosystem [12,13].

2.3. Review of Research on Governance Mechanisms for Regional Innovation Ecosystems

Conceptually, the integration of artificial intelligence (AI) technology has revitalized innovation. Through big data analytics, machine learning, and other technological means, AI enables more efficient allocation and utilization of innovation factors [14]. Implementation mechanisms primarily encompass three aspects: First, by enhancing data processing and decision-making efficiency, AI significantly improves the allocation efficiency of innovation resources within a region, reduces information asymmetry, and optimizes resource utilization. Second, AI technologies foster collaboration among innovation actors. Through intelligent tools and platforms, cooperation between governments, enterprises, and research institutions becomes tighter and more efficient, driving regional innovation activities. Third, AI technologies enhance the stability and sustainability of regional innovation through predictive analytics and risk management, ensuring the healthy operation of the innovation ecosystem [6,15]. Key influencing factors include policy support, technological infrastructure, societal acceptance, and multi-stakeholder coordination capabilities. Government policy support and institutional design directly impact the breadth and depth of AI application in regional innovation. Advanced technological infrastructure provides essential conditions for effective AI deployment. Public acceptance of AI technology and multi-stakeholder coordination capabilities are also critical determinants of the system's successful operation [16–18].

2.4. Literature Review

In the era of artificial intelligence, the structural characteristics of regional innovation ecosystems exhibit three notable shifts: First, the boundaries between innovation actors are becoming increasingly blurred, with human-machine collaboration emerging as the new norm. Second, the pace of innovation activities has accelerated, with exploratory and exploitative innovation occurring in parallel. Third, innovation spaces are characterized by the convergence of physical and virtual dimensions, with the physical world and digital space jointly constituting the innovation arena. While existing research has addressed AI applications in regional innovation, it exhibits three shortcomings: First, most studies focus on the technological dimension while neglecting institutional and cultural factors. Second, they emphasize AI deployment by single actors or in isolated stages, lacking a systemic ecological perspective. Third, they inadequately address the governance challenges posed by AI.

This study identifies three major challenges in leveraging AI to empower regional innovation ecosystem governance: First, data governance challenges encompass issues like data silos, data quality, data security, and privacy protection. Second, algorithmic governance challenges, involving algorithmic transparency, fairness, and accountability mechanisms. Third, innovation governance challenges, manifested in balancing exploratory and exploitative innovation and resolving the tension between technological standardization and diversification. The enabling mechanisms of AI for regional innovation ecosystems primarily manifest across three dimensions: technological empowerment, data-driven approaches, and networked collaboration. Technological empowerment enhances the cognitive capabilities of innovation actors through machine learning, natural language processing, computer vision, and other technologies, expanding the boundaries for solving complex problems. Data-driven innovation accelerates knowledge production and technological iteration by extracting valuable insights and patterns from massive datasets, thereby reducing innovation uncertainty. Network-based collaboration enhances knowledge flow and resource allocation within innovation networks by optimizing connectivity efficiency.

3. Theoretical Framework for AI-Empowered Regional Innovation Ecosystems

3.1. Defining Core Concepts

Artificial intelligence-empowered regional innovation ecosystems refer to open, self-organizing, and

adaptive complex systems within specific geographic areas. These systems leverage AI technology as the core driving force, bringing together diverse innovation actors—including governments, enterprises, universities, research institutions, financial institutions, and intermediary service organizations. Through intelligent platform connectivity, data circulation, and algorithm-driven decision-making, they facilitate knowledge creation, technological innovation, and value co-creation. This system exhibits four core characteristics: First, intelligence-driven nature, where AI technology permeates the entire innovation process, serving as the critical link connecting all innovation entities and optimizing resource allocation. Second, platform-based organization, achieved by constructing intelligent innovation platforms that enable efficient aggregation and precise matching of innovation factors. Third, data-empowered capability, where data becomes the core production factor, driving value creation through data flow and intelligent analysis. Fourth, dynamic evolution, enabling the system to autonomously learn and optimize itself in response to changes in both internal and external environments.

3.2. System Components

The AI-Empowered Regional Innovation Ecosystem comprises four layers: the Technology Layer, the Entity Layer, the Platform Layer, and the Environment Layer.

The Technology Layer serves as the foundational support for system operation, encompassing algorithmic technologies, computing infrastructure, data resources, and intelligent application tools. Core algorithms such as machine learning, deep learning, natural language processing, and computer vision provide intelligent capabilities for innovation activities; computing facilities like cloud computing centers and intelligent computing centers support large-scale data processing and model training; The collection, storage, governance, and sharing of multi-source heterogeneous data supply production factors for value creation; various intelligent application tools empower innovation entities to enhance efficiency.

The entity layer encompasses innovative enterprises, universities and research institutions, government departments, financial institutions, intermediary service organizations, and individual innovators. Under AI empowerment, the roles and functions of these entities undergo significant transformation. Enterprises evolve from mere technology adopters into collaborative builders of the ecosystem; Universities and research institutions not only provide fundamental research support but also become hubs for open innovation through data and algorithm sharing; governments evolve from regulators to ecosystem cultivators and rule-makers; financial institutions deliver more efficient funding support for innovation activities through intelligent risk control and precise profiling.

The platform layer serves as the intermediary connecting technology and entities, encompassing data sharing platforms, open algorithm platforms, industry-academia-research collaboration platforms, and supply-demand matching platforms. These platforms reduce transaction costs among innovation entities through standardized interfaces, intelligent matching algorithms, and trusted transaction mechanisms, facilitating the efficient flow and optimized allocation of innovation factors.

The environmental layer encompasses policy, market, cultural, and infrastructure environments. AI empowerment requires corresponding institutional frameworks and environmental cultivation, including data market rules, algorithmic ethics standards, intellectual property protection mechanisms, and talent development systems.

3.3. Reconstructing the Logic of Co-Creating Value

Empowered by artificial intelligence, the value co-creation logic of regional innovation ecosystems undergoes a fundamental transformation, shifting from traditional linear value chains to networked value co-creation networks. This forms a cyclical mechanism of “perception-matching-collaboration-evolution.”

During the perception phase, AI technologies precisely identify innovation demands, resources, and opportunities through real-time collection and intelligent analysis of massive datasets. Machine learning algorithms extract latent market needs from commercial data, uncover technological trends from research outputs, and detect shifts in the innovation environment from social indicators—laying a precise informational foundation for value co-creation.

During the matching phase, intelligent algorithms achieve multidimensional precision matching of

innovation entities, resources, and demands based on perceived information. Unlike traditional manual brokerage or simple keyword searches, AI employs deep learning to understand capability profiles, resource characteristics, and demand traits of innovation actors, enabling cross-domain, cross-level intelligent matching that significantly reduces search and transaction costs.

Collaboration Phase: Successfully matched innovation entities engage in joint R&D, technology transfer, and commercialization activities through an intelligent collaboration platform. AI provides end-to-end support for collaborative innovation, including intelligent project management, automated knowledge sharing, streamlined communication, and real-time risk monitoring. Particularly in complex innovation projects, AI coordinates multiple stakeholders, optimizes resource allocation, and predicts risk bottlenecks, significantly enhancing collaborative innovation efficiency.

In the evolution phase, AI continuously refines matching algorithms, enhances collaboration mechanisms, and improves governance rules through ongoing learning from innovation process data, propelling the entire ecosystem toward higher levels of sophistication. The system possesses self-diagnostic, self-adjusting, and self-optimizing capabilities, dynamically adapting its structure and functions to internal and external environmental changes to sustain perpetual innovation vitality.

The crux of this cyclical mechanism lies in data flow and embedded intelligence. Data is continuously generated, circulated, and enhanced across perception, matching, collaboration, and evolution stages, forming a data-driven value creation flywheel. AI serves as the system's "intellectual hub," integrating dispersed innovation entities and fragmented resources into an organic whole, achieving a fundamental shift from isolated efforts to collaborative co-creation.

4. Mechanism Analysis of Artificial Intelligence Empowering Regional Innovation Ecosystems

4.1. Knowledge Empowerment Mechanism

Artificial intelligence breaks through the temporal and spatial constraints of traditional knowledge management through methods such as knowledge graph construction, intelligent retrieval, knowledge recommendation, and knowledge creation, enabling the intelligent acquisition, dissemination, and application of knowledge.

AI technology can extract knowledge from massive amounts of unstructured data-including literature, patents, and reports-to build interdisciplinary and cross-domain knowledge graphs. These knowledge graphs not only provide structured representations of explicit knowledge but also leverage deep learning to uncover implicit knowledge and interconnections, offering innovation entities a panoramic view of knowledge. For instance, through patent knowledge graph analysis, enterprises can swiftly identify technological frontiers, gaps, and evolution paths, providing scientific grounds for R&D decision-making.

Intelligent retrieval and personalized recommendation technologies are transforming knowledge acquisition. Traditional keyword searches often suffer from information overload and insufficient precision, whereas AI understands user intent and analyzes usage contexts to deliver precisely targeted, highly relevant knowledge resources. Natural language processing enables more intuitive human-machine interaction, lowering the barrier to knowledge access-particularly for SMEs and startups-by providing high-quality knowledge resources at lower costs.

AI propels knowledge from static storage toward dynamic creation. Machine learning algorithms uncover novel patterns and rules within big data, aiding human scientific discovery and technological invention. Generative AI demonstrates immense potential in drug development, materials design, and product innovation. Through algorithmic simulation and optimization, it significantly shortens R&D cycles and reduces costs, establishing human-machine collaborative knowledge creation as a new paradigm for innovation.

The effective operation of knowledge empowerment mechanisms requires establishing an open and shared knowledge ecosystem. Governments should promote the openness of public scientific and technological data and support the development of industry knowledge platforms. Enterprises should break down knowledge silos, participating in knowledge sharing while protecting core technologies. Universities and research institutions should strengthen knowledge transformation, converting scientific research outcomes into applicable knowledge resources.

4.2. Resource Allocation Optimization Mechanism

Artificial intelligence drives innovation resources from extensive allocation to precise allocation, and from static allocation to dynamic optimization through intelligent matching of supply and demand, dynamic resource allocation, and efficiency assessment.

In talent resource allocation, AI platforms enable precise matching based on project requirements and talent capabilities. Unlike traditional explicit indicators such as academic credentials and professional titles, AI constructs more comprehensive talent profiles by analyzing multidimensional information including project experience, skill maps, and collaboration networks, thereby achieving “the right person for the right role.” Simultaneously, intelligent talent mobility mechanisms enable flexible movement across projects and organizations, transcending traditional organizational boundaries to foster an open talent ecosystem.

In financial resource allocation, AI-empowered fintech delivers more efficient funding support for innovation activities. Intelligent risk control systems analyze multidimensional corporate data to assess innovation capabilities and growth potential, providing more precise credit evaluations for technology-based SMEs. Smart investment advisory systems assist institutions in identifying high-quality projects while reducing information asymmetry. The integration of blockchain and AI enables transparent oversight of capital flows, ensuring fund security.

Regarding scientific facility allocation, intelligent large-scale research facility sharing platforms achieve intensive equipment utilization. IoT sensors monitor equipment status in real time, while AI algorithms optimize scheduling, enhancing utilization rates and reducing R&D costs for SMEs. Virtual simulation technology can partially replace physical facilities, further improving resource allocation efficiency.

For data resource allocation, establishing data element markets and trading platforms enables the circulation and sharing of data value while protecting privacy through technologies like privacy-preserving computation and federated learning. An AI-driven data governance system ensures data quality, security, and compliance, providing institutional safeguards for efficient data resource allocation.

4.3. Collaborative Innovation Promotion Mechanism

Artificial intelligence provides technological support and organizational model innovation for cross-organizational, cross-domain, and cross-regional collaborative innovation, driving the shift from “individual efforts” to “collaborative problem-solving.”

In building collaborative innovation networks, AI employs techniques such as social network analysis and relationship mining to identify key nodes, core pathways, and potential partnerships within innovation ecosystems, providing a scientific basis for constructing collaborative innovation networks. Big data-driven industrial chain mapping analysis helps enterprises identify optimal upstream and downstream partners to form industrial collaborative innovation alliances.

For collaborative innovation process management, intelligent project management platforms enable visualized, transparent multi-party coordination. Features like task decomposition, real-time progress monitoring, risk alerts, and dynamic resource allocation significantly enhance collaborative efficiency. Blockchain technology safeguards intellectual property ownership and benefit distribution during collaboration, mitigating associated risks.

In cross-domain collaborative innovation, artificial intelligence breaks down disciplinary barriers and sector boundaries. Through cross-domain knowledge integration and technology transfer learning, it promotes the convergence of knowledge and technologies across different disciplines and industries. For instance, the intersection of biomedicine and AI has spawned intelligent diagnostics, while the integration of materials science and AI accelerates new material R&D.

In open innovation, AI platforms lower participation barriers, enabling individual innovators and SMEs to engage equally in large-scale innovation projects. New organizational forms like crowdsourced innovation and maker spaces demonstrate enhanced vitality when supported by AI. Mechanisms such as open-source communities and innovation competitions stimulate societal innovation vitality.

4.4. Risk Intelligence Management Mechanism

Innovation activities carry high risks and uncertainties. Artificial intelligence provides end-to-end risk management capabilities for innovation ecosystems through risk identification, assessment, early warning, and response.

In managing technological risks, AI evaluates technical feasibility and predicts maturity levels in project early stages using specialized models. Simulation technologies test technical solutions in virtual environments, reducing trial-and-error costs. Technology monitoring and early warning systems track technological developments in real time, promptly identifying risks of technological substitution and path dependency.

For market risk management, AI assists innovators in seizing market opportunities and mitigating risks through market demand forecasting, competitive landscape analysis, and price trend prediction. Technologies like social media sentiment analysis and user behavior analysis provide real-time insights into market shifts, supporting product adjustments and strategic planning.

For compliance risk management, intelligent legal monitoring systems automatically identify compliance vulnerabilities in innovation activities. Intelligent intellectual property search systems conduct early-stage patent infringement risk assessments during R&D. Data compliance review systems ensure data collection and usage align with relevant laws and regulations.

Regarding systemic risk management, ecosystem risk transmission models identify fragile links and risk sources within systems. Stress testing and scenario simulations evaluate ecosystem resilience under extreme conditions. Early warning systems trigger alerts when risks accumulate to a critical level, buying valuable time for risk mitigation.

Intelligent risk management does not eliminate risks but encourages exploration and innovation within tolerable risk parameters. Establishing a tolerance-for-error mechanism is equally crucial. This requires creating an institutionally inclusive environment for innovation failures and leveraging AI to reduce trial-and-error costs at the technical level, fostering an innovation culture that “encourages innovation and tolerates failure.”

5. Case Study of AI Empowering Regional Innovation Ecosystems: The Yangtze River Delta Regional Innovation Ecosystem

5.1. Case Background

The Yangtze River Delta region serves as a vital hub for China’s artificial intelligence industry, gathering a large number of AI enterprises, research institutions, and innovation resources. Cities such as Shanghai, Hangzhou, Nanjing, and Hefei each possess distinctive strengths in the AI field, forming a regional innovation ecosystem characterized by complementary advantages and collaborative development. As of August 2025, the Yangtze River Delta region hosts 458 AI-listed companies nationwide, accounting for 35% of the total. It has developed a multi-center layout with no significant weaknesses: Jiangsu Province has 146 companies, Zhejiang Province 140, Shanghai 123, and Anhui Province 49—though relatively fewer, it still maintains a considerable scale. The Yangtze River Delta Integration Development Strategy provides policy support and institutional safeguards for building the regional innovation ecosystem.

5.2. Empowering the Yangtze River Delta Regional Innovation Ecosystem with Artificial Intelligence

The Yangtze River Delta regional innovation ecosystem leverages artificial intelligence through multiple channels. In terms of knowledge empowerment, it has established a series of open AI innovation platforms—such as the Shanghai AI Laboratory and Zhejiang Laboratory—providing nationwide computing power support, data services, and technology sharing. These platforms break away from the closed model of traditional research institutions, enabling the open flow of knowledge. Regarding resource allocation optimization, the region has established a cross-regional innovation resource sharing mechanism. Zhejiang’s strengths in the digital economy, Jiangsu’s manufacturing foundation, Anhui’s scientific and educational resources, and Shanghai’s financial services and international advantages complement each other. By building a regional digital platform for innovation resources, the region has facilitated the cross-regional flow and optimized allocation of factors

such as talent, capital, technology, and data. In promoting collaborative innovation, the Yangtze River Delta has formed a synergistic innovation network deeply integrating industry, academia, research, and application. AI enterprises have established joint laboratories with universities and research institutes to tackle technological challenges; leading enterprises and SMEs have formed industrial chain collaborations to jointly explore markets; and industrial alliances have been established between different cities to avoid homogeneous competition. Regarding risk management, the Yangtze River Delta has established an AI safety governance framework, including mechanisms such as algorithm filing systems, data security assessments, and ethical reviews, to prevent technological and social risks while encouraging innovation.

5.3. AI-Empowered Value Co-Creation Practices in the Yangtze River Delta Regional Innovation Ecosystem

The Yangtze River Delta artificial intelligence innovation ecosystem exhibits characteristics of a hybrid value co-creation model. At the platform level, large platforms such as the Shanghai AI Institute serve as core hubs, providing infrastructure and public services. At the network level, numerous small and medium-sized enterprises and startup teams engage in specialized innovation through peer-to-peer collaboration. Notable examples of value co-creation include: collaborative innovation in the intelligent connected vehicle industry, where automakers, AI enterprises, academic research institutions, and government departments jointly advance technology development and standardization; AI-empowered innovation in biopharmaceuticals, where artificial intelligence is applied to drug discovery, clinical diagnostics, and health management, significantly shortening R&D cycles and reducing costs; and multi-stakeholder participation in smart city development, where governments provide scenarios and data while enterprises contribute technology and services to jointly build intelligent urban governance systems. Regarding value distribution, the Yangtze River Delta has explored multiple models. For government-led major projects, mechanisms like “posting challenges and recruiting champions” are employed, with rewards based on innovation outcomes. Market-driven projects utilize equity investment and profit-sharing approaches. Open-source and open-access projects generate returns through technical services and brand value.

5.4. Governance Mechanisms for the Yangtze River Delta Regional Innovation Ecosystem Empowered by Artificial Intelligence

The Yangtze River Delta region has actively explored governance mechanisms. In terms of multi-stakeholder collaborative governance, it has established the Yangtze River Delta Integrated Development Coordination Mechanism, holding regular joint meetings to coordinate major cross-regional matters. The Yangtze River Delta Artificial Intelligence Industry Alliance was founded to leverage industry self-regulation and coordination. Regarding data circulation, the Yangtze River Delta Integrated Public Data Platform was developed to facilitate cross-regional sharing of government data. Efforts are underway to establish a data exchange, develop data transaction rules, and set technical standards. Technologies like privacy computing are applied to facilitate data circulation while ensuring security. For intelligent regulation, a regional collaborative oversight mechanism has been established to achieve regulatory information sharing and enforcement coordination. AI technologies enhance regulatory efficiency, such as identifying risks through intelligent public sentiment monitoring systems and ensuring regulatory process transparency via blockchain technology. Regarding incentive mechanisms, local governments have introduced a series of policy measures supporting AI development, including financial subsidies, tax incentives, and talent recruitment programs. A mechanism for error tolerance and exemption from liability has been established to encourage bold innovation by government departments and enterprises.

5.5. Lessons Learned

The Yangtze River Delta case offers the following insights: First, regional coordination serves as a crucial foundation for AI-empowered innovation ecosystems, requiring the dismantling of administrative barriers and the establishment of integrated development mechanisms. Second, platform development is a key driver for AI

empowerment, leveraging the core hub role of large-scale open platforms to cultivate a multi-tiered innovation platform system. Third, institutional innovation is a vital safeguard for AI empowerment, requiring pioneering efforts in data circulation, intellectual property protection, and regulatory innovation. Fourth, scenario openness is a crucial pathway for AI empowerment, necessitating the provision of diverse application scenarios to iteratively optimize AI technologies through practical use. Fifth, talent cultivation is the fundamental pillar of AI empowerment, demanding strengthened AI talent development alongside improved mechanisms for talent recruitment and utilization.

6. Implementation Pathways for AI-Empowered Governance Mechanisms in Regional Innovation Ecosystems

6.1. Government Role Redefinition and Policy Tool Innovation

Within AI-empowered regional innovation ecosystems, the government's role must evolve from traditional administrator to ecosystem builder and collaborative governance partner. Therefore, the foremost task in reshaping the government's role is to establish a long-term oriented innovation governance philosophy, avoiding distortion of the regional innovation ecosystem due to pursuit of short-term political achievements.

Policy tool innovation can be pursued through the following avenues: First, implementing a comprehensive policy support system covering the entire innovation process—from fundamental research and technology development to industrialization. For instance, Chengdu's "Four Major Public Platform Supply Initiatives" (computing power, training grounds, pilot testing, scenario validation) provide targeted policy support addressing critical bottlenecks across the AI innovation chain. Second, adopting scenario-driven policy design by opening public scenario resources to provide testing spaces and application outlets for AI technological innovation. Chengdu's plan explicitly proposes an "Application Scenario Expansion Initiative" across six sectors—"pharmaceuticals and healthcare, low-altitude economy, urban governance, cultural tourism, commercial retail, and education"—demonstrating a scenario-oriented policy approach. Third, explore agile governance and adaptive policy tools, such as the "regulatory sandbox" and innovation exemptions discussed below, enabling the policy framework to adapt to the rapid iteration of AI technologies.

Governments must also prioritize differentiated policy guidance to prevent homogenized competition in AI development across regions. Development pathways should be tailored based on each area's industrial foundation, resource endowments, and comparative advantages. For instance, the Yangtze River Delta region's proposed "Brain-Body-Field" linkage strategy involves Shanghai focusing on "brain-end" technologies (large models and spatial intelligence), Jiangsu strengthening "body-end" segments (automated control and key components), Zhejiang building "spatial training fields," and Anhui leveraging its research strengths in brain-inspired intelligence and intelligent speech. This division of labor model based on regional advantages effectively prevents resource wastage caused by homogeneous competition.

6.2. Data Governance and Ethical Security Framework

Data is the core element of artificial intelligence innovation, making it crucial to establish a data governance system that adapts to AI development. The World Economic Forum's Blueprint for the Intelligent Economy highlights that collecting diverse, high-quality datasets is a key strategic objective for intelligent economies. However, current challenges include difficulties in data acquisition, data inequality, unclear data ownership, and data trust issues. To address these challenges, regional data governance frameworks should focus on three dimensions: data openness and sharing, data quality assurance, and data security protection.

Regarding data openness and sharing, international experiences can be leveraged to establish a tiered and categorized public data release mechanism. This approach maximizes the value of public data while safeguarding national security and personal privacy. Concurrently, enterprises should be encouraged to promote conditional sharing of commercial data through innovative models such as data alliances and data trusts. For data quality assurance, a comprehensive lifecycle data quality management system must be implemented, encompassing data collection standards, storage protocols, and update mechanisms. For data security protection, a balance must be struck between data utilization and security. Technologies like privacy computing and

blockchain should be employed to achieve a secure utilization model where “data is usable but not visible.”

Ethical safety is the cornerstone for the sustainable development of AI innovation. The construction of an ethical safety framework should focus on three key areas: First, establishing ethical guidelines and standards to define the ethical baseline and red lines for AI research, development, and application. Second, developing algorithmic audit and evaluation mechanisms to implement full-process oversight of high-risk AI systems, encompassing pre-deployment assessments, real-time monitoring, and post-incident audits. Third, creating rights protection and redress channels to ensure individuals harmed by AI applications can obtain effective legal remedies. The “AI Collaborative Governance Workstation” established in Shanghai’s Xuhui District, which integrates judicial, administrative, and regulatory resources, represents a valuable attempt to build such an ethical safety framework.

6.3. Multi-Level Regional Collaborative Governance System

Artificial intelligence innovation activities exhibit pronounced cross-regional characteristics, making the establishment of a multi-tiered regional collaborative governance system crucial. Practices in the Yangtze River Delta region demonstrate that efficient regional coordination can significantly enhance innovation effectiveness. At the macro level, a central-local coordination mechanism can be established, including the linkage between national AI innovation development initiatives and regional demonstration applications, to avoid redundant construction and scattered resources. At the meso level, refining inter-regional cooperation mechanisms-such as the “three-tiered collaboration” (decision-making, coordination, and execution layers) established in the Yangtze River Delta-provides institutional safeguards for cross-provincial AI collaborative innovation. At the micro level, encourage spontaneous networked collaboration among innovation entities, such as R&D alliances between enterprises and cooperative research among universities.

Specifically for the AI industry, the approach proposed by the Yangtze River Delta-where the Shanghai-Nanjing Industrial Innovation Belt serves as the central axis for collaborative AI innovation extending across the entire region-can be adopted. Through cross-provincial policy coordination, industrial chain division of labor, and shared research outcomes, a full-chain ecosystem can be formed, spanning core algorithm R&D to critical component manufacturing, and from large-scale scenario validation to commercialization. This industrial chain-based collaborative governance effectively addresses the limitations of individual regions in terms of resources and application scenarios, enabling complementary strengths and mutually beneficial cooperation across regions.

7. Research Findings and Policy Implications

7.1. Research Findings

Through theoretical analysis and case studies, this paper draws the following research findings:

First, artificial intelligence has profoundly reshaped the internal structure and value creation logic of regional innovation ecosystems through its three technological pillars: data, algorithms, and computing power. Empowered by AI, regional innovation ecosystems exhibit new characteristics: blurred boundaries among key players, accelerated innovation cycles, and the convergence of physical and virtual innovation spaces. Value co-creation mechanisms have shifted from linear chains to networked collaboration.

Second, China’s regional AI innovation ecosystems have developed diverse pathways. The Yangtze River Delta region leads national AI advancement through its “multi-center balanced layout” and “high-efficiency regional coordination.” Chengdu pursues a differentiated “embodied intelligence” track with a full-chain breakthrough strategy. Shanghai’s Xuhui District explores a dual-track model emphasizing “full-chain innovation ecosystems” and “collaborative governance”. These diverse approaches provide varied reference models for different regions.

Third, the value co-creation of AI-empowered regional innovation ecosystems follows an evolutionary logic of “data weaving-platform collaboration-ecosystem alliance”. Governments establish end-to-end data element ecosystems through data resource and asset allocation. Building upon this foundation, AI innovation platforms are constructed to form resource allocation and control mechanisms. Ultimately, ecosystem alliances enable the

ecological transformation of innovation processes and the scaling of value co-creation.

Fourth, effective governance mechanisms are essential for ensuring the healthy development of AI-empowered regional innovation ecosystems. Current governance challenges include: short-term perspectives of local governments stifling exploratory innovation, data silos and ethical issues, and inadequate regional coordination mechanisms. These issues require resolution through innovative governance approaches.

7.2. Policy Recommendations

Based on the research findings, this paper proposes the following policy recommendations:

First, pursue differentiated regional AI innovation strategies to avoid homogenized competition. Each region should select an appropriate AI development path based on its industrial foundation, resource endowments, and comparative advantages. Regions with strong manufacturing bases can prioritize “AI + Manufacturing,” areas rich in research resources can focus on breakthroughs in fundamental algorithms and core technologies, while regions with abundant application scenarios can explore the “AI + Scenario” model. The Yangtze River Delta’s “multi-center balanced development” model and Chengdu’s “differentiated track selection” strategy offer valuable references for diverse regional types.

Second, establish a long-term oriented innovation governance system to balance exploratory and applied innovation. The central government should guide and incentivize local governments to adopt long-term development philosophies, reforming performance evaluation systems to increase weighting for long-term objectives while reducing excessive emphasis on short-term economic growth and investment returns. When formulating innovation policies, local governments must prioritize safeguarding enterprises’ capacity for sustained innovation investment. Establishing multi-year fiscal support mechanisms can alleviate businesses’ reliance on short-term gains.

Third, refine data governance and ethical security frameworks to balance innovation with regulation. On one hand, establish robust rules for data element markets to facilitate orderly data flow and efficient resource allocation. On the other, build an AI ethical governance system encompassing ethical guidelines, algorithmic auditing, and security assessment mechanisms. The collaborative governance model of Shanghai’s Xuhui District “AI Collaborative Governance Workstation” offers replicable experience for balancing innovation incentives and risk prevention at the local level.

Fourth, foster a multi-stakeholder regional coordination mechanism to enhance the overall effectiveness of the innovation ecosystem. Drawing on the World Economic Forum’s concept of “enhancing AI competitiveness through regional cooperation,” strengthen inter-regional collaboration in AI infrastructure development, data resource sharing, and mutual recognition of standards. Simultaneously, fully leverage the roles of diverse stakeholders-including enterprises, universities, research institutions, and users-in governance to establish a regional innovation governance framework characterized by joint construction, co-governance, and shared benefits.

7.3. Research Limitations and Future Prospects

This study has certain limitations: First, it is based on macro-regional analysis with insufficient examination of micro-level subject behaviors; second, it focuses on mechanism design with relatively limited exploration of specific policy tools; third, the analysis of international experience requires further deepening. Future research may expand in the following directions: First, examine at the micro level how policy orientations influence regional enterprise innovation decisions and how imitation behaviors among local governments spread to regional innovation actors. Second, conduct in-depth analysis of the differential effects of various policy tools (e. g., tax incentives, R&D subsidies, scenario openness) on AI innovation. Third, undertake cross-national comparative studies to identify key institutional and cultural factors influencing the effectiveness of regional AI innovation ecosystems. As breakthroughs continue in generative AI, embodied intelligence, and related technologies, the mechanisms and pathways through which AI empowers regional innovation ecosystems will evolve further. This necessitates sustained tracking and research by both academia and practitioners to refine theoretical frameworks and governance models, thereby providing stronger theoretical support for advancing high-quality development of AI and regional innovation in China.

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Not applicable.

Data Availability Statement

Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

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