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Institutional Innovation and Diffusion Patterns of Inclusive AI at County Level: Evidence from Private Economy-Dominated Regions

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Abstract

The integration of artificial intelligence (AI) and inclusive growth drives transitional economies to narrow regional gaps and pursue common prosperity. China's private economy-dominated areas are characterized by industrial clusters, market-based operations and severe urban-rural imbalances, creating a unique context for inclusive AI diffusion at the county level. Taking Wenzhou, a private economic hub in Zhejiang's Common Prosperity Demonstration Zone, as the research sample, this paper adopts field surveys and empirical data to construct a four-dimensional theoretical framework: institutional supply, market adoption, inclusive diffusion and common prosperity empowerment. It systematically explores institutional barriers, innovative mechanisms and spatial diffusion modes of grassroots inclusive AI. The results identify four core constraints on AI popularization: uneven technological resource distribution, cross-regional data isolation, insufficient digital literacy of rural laborers, and high transformation costs for private SMEs. Targeted institutional innovations including tiered financial subsidies, industrial chain coordination, inclusive public computing power and multi-stakeholder co-governance can eliminate the "urban technological highland versus county technological lowland" gap. This study summarizes three localized diffusion patterns: leader-driven chain diffusion, platform-enabled cluster diffusion and scenario-oriented gradient diffusion. Mechanism tests verify that inclusive AI realizes common prosperity through three core paths: industrial efficiency growth, equalized public services and labor skill upgrading. This research expands the theoretical meaning of AI diffusion under institutional limits, provides localized institutional schemes for county-level digital inclusion, and offers practical references for emerging economies to coordinate technological progress and inclusive growth.

Keywords

Inclusive Artificial Intelligence; Institutional Innovation; Technology Diffusion; County-Level Development; Private Economy; Common Prosperity; Regional Balanced Development

1. Introduction

1.1. Research Background

The new round of technological revolution centered on artificial intelligence has profoundly reshaped industrial layouts, resource allocation efficiency, and public service supply models worldwide. As a general-purpose key technology, AI exhibits unique characteristics of marginal cost reduction, cross-scenario penetration, and resource break-through, which can effectively alleviate unbalanced and inadequate regional development (Wang et al., 2025). Against the backdrop of China's Common Prosperity Demonstration Zone construction and the national "AI+" strategy, digital inclusive development has evolved from a developmental concept to a core institutional arrangement for narrowing urban-rural and inter-county gaps.

Private economy-dominated regions represented by Wenzhou are typical carriers of China's market-oriented economic transformation. These regions boast active private SMEs, complete traditional industrial clusters such as footwear, electrical equipment, and auto parts, and flexible market resource allocation mechanisms. However, they also face prominent development dilemmas: extreme unbalanced regional economic levels, mismatched public service resources, and blocked cross-regional flow of technical and talent elements. Statistical data show that the per capita GDP of Lucheng District (128,000 yuan) is 3.7 times that of Taishun County (35,000 yuan) in Wenzhou. Over 60% of large-scale industrial enterprises are concentrated in urban areas, while remote counties rely heavily on traditional agriculture and low-end manufacturing. The digital technology adoption rate of local private SMEs is less than 20%, forming a typical "technological divide" between urban core areas and peripheral counties (Zhang, 2022).

Existing AI applications in private economies are mostly concentrated in urban leading enterprises and high-value-added industrial links, while county-level grassroots scenarios such as rural public services, traditional low-end manufacturing, and elderly care services suffer from insufficient AI penetration and serious inclusive deficiencies. The fundamental reason lies in the lack of targeted institutional arrangements and adaptive diffusion models suitable for county-level scenarios and private SME clusters. Therefore, exploring institutional innovation paths and efficient diffusion patterns of inclusive AI at the county level is crucial for enabling technological progress to benefit underdeveloped regions and vulnerable groups, and realizing organic unity between technological efficiency and social equity. The spatial imbalance of AI resources across Wenzhou's counties is visualized in Figure 1.

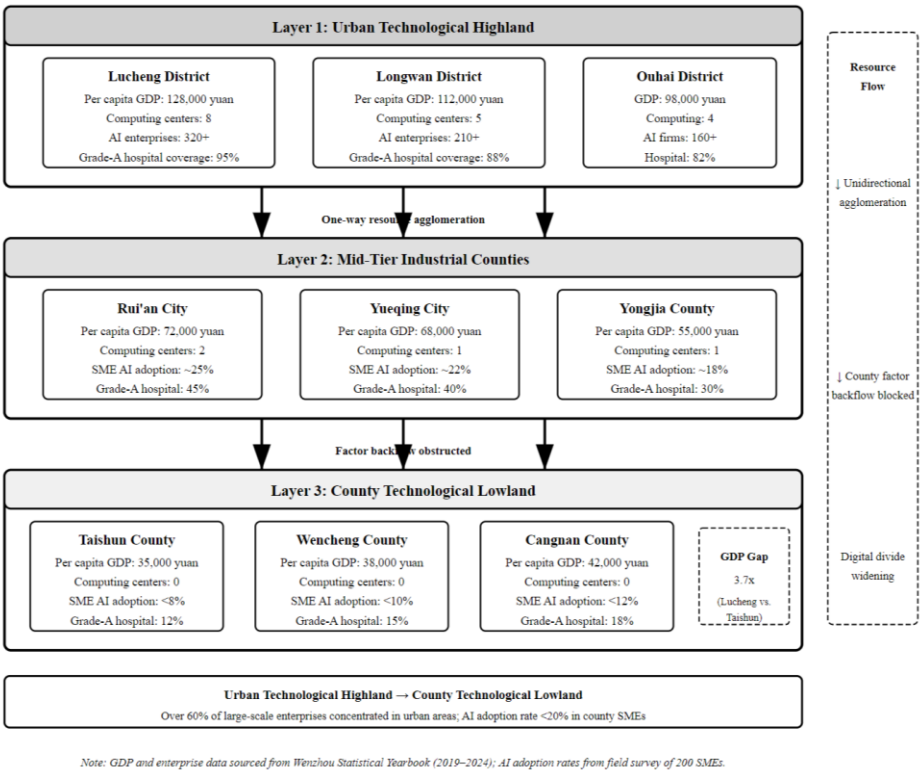


Figure 1. Spatial stratification of AI resources across Wenzhou's counties. The three-layer structure illustrates the "urban technological highland vs. county technological lowland" divide: Layer 1 (urban core: Lucheng, Longwan, Ouhai) concentrates over 90% of computing power and AI enterprises; Layer 2 (mid-tier industrial counties: Rui'an, Yueqing, Yongjia) shows partial technology penetration; Layer 3 (remote mountainous counties: Taishun, Wencheng, Cangnan) suffers from near-zero computing infrastructure and AI adoption below 12%. The per capita GDP gap between Lucheng and Taishun reaches 3.7 times.

1.2. Literature Review and Research Gaps

Traditional technology diffusion theory focuses on the progressive penetration process of innovative technologies driven by market demand and enterprise heterogeneity (Wang et al., 2025). Subsequent industrial cluster theory further supplements the mechanism of knowledge spillover and network synergy accelerating technology diffusion (Xin et al., 2025). In the digital economy era, AI technology differs from traditional technologies in non-competitiveness, high permeability, and data dependence, making its diffusion process more susceptible to institutional constraints, infrastructure endowments, and regional resource differences. Existing studies mainly focus on macro-national or urban-industrial AI diffusion, while ignoring the micro-institutional friction and scenario adaptation problems in county-level grassroots diffusion.

Inclusive AI emphasizes breaking resource barriers through technological innovation, realizing equal access to digital dividends for different regions, industries, and groups (Wang et al., 2024). Current literature confirms that AI can empower common prosperity by improving industrial productivity, optimizing

public service allocation, and optimizing employment structures. However, most studies overlook the endogenous constraints of regional economic structures, especially the unique dilemma of inclusive AI diffusion in private economy-dominated regions dominated by SMEs. Few studies systematically discuss the matching mechanism between institutional innovation and county-level inclusive AI diffusion, lacking localized theoretical frameworks and empirical summaries of diffusion patterns (Hayward, 2026).

Three core research gaps remain in existing studies. First, most studies focus on the economic efficiency of AI, while neglecting the institutional obstacles restricting inclusive diffusion at the county level. Second, there is a lack of targeted summary of AI diffusion patterns adapted to private SME clusters and underdeveloped county scenarios. Third, the mechanism path of institutional innovation empowering inclusive AI to bridge regional development gaps has not been theoretically refined and empirically tested. This study fills the above gaps by taking Wenzhou's county-level practice as a sample.

1.3. Research Objectives and Contributions

This study aims to clarify the institutional constraints of county-level inclusive AI diffusion in private economy-dominated regions, summarize typical inclusive AI diffusion patterns, and reveal the internal mechanism of institutional innovation driving inclusive AI to empower regional common prosperity. The marginal contributions are as follows: First, it constructs a unique theoretical framework for county-level inclusive AI diffusion adapted to private economy scenarios, expanding the application boundary of digital technology diffusion theory. Second, it summarizes three localized inclusive AI diffusion patterns, providing replicable practical paradigms for county-level digital inclusive development. Third, it clarifies the multi-dimensional empowerment mechanism of inclusive AI for common prosperity, providing empirical support for balancing technological progress and social equity in transitional economies.

2. Theoretical Framework and Research Hypotheses

2.1. Connotation Definition

County-level Inclusive AI: Different from efficiency-oriented industrial AI, inclusive AI takes narrowing regional gaps, equalizing public services, and optimizing opportunity allocation as the core goals, covering inclusive application scenarios such as county traditional industrial intelligent transformation, remote medical and educational public services, precise social security, and rural digital governance.

Private Economy-Dominated Regions: Regions with private economy as the main body of economic development, characterized by a large number of SMEs, clustered traditional industries, flexible market mechanisms, and prominent urban-rural dual

economic differences, represented by Wenzhou in this study.

Institutional Innovation of Inclusive AI: A series of institutional arrangements including policy guidance, resource allocation, industrial collaboration, and social co-governance formulated to break county-level digital divides, reduce SME AI transformation costs, and promote equitable diffusion of AI technological dividends.

2.2. Theoretical Mechanism Analysis

This study constructs a four-dimensional theoretical framework shown in Figure 2. Combined with the empirical characteristics of Wenzhou's counties, the inclusive AI diffusion in private economy-dominated regions faces four major institutional and practical constraints. First, resource allocation imbalance: Over 90% of computing power centers, AI laboratories, and R&D resources are concentrated in urban core areas, while county-level technological infrastructure is insufficient. Second,market adoption barriers: The average intelligent transformation cost of private SMEs exceeds 5 million yuan, with an AI technology adoption rate of less than 20%, and small enterprises lack the ability and willingness to transform. Third, element flow barriers: The digital skill level of county laborers is low (only 12% of workers have digital skills), and the outflow of young population in underdeveloped counties is serious. Fourth, data institutional barriers: Cross-department and cross-county data isolation leads to insufficient data support for grassroots AI applications.

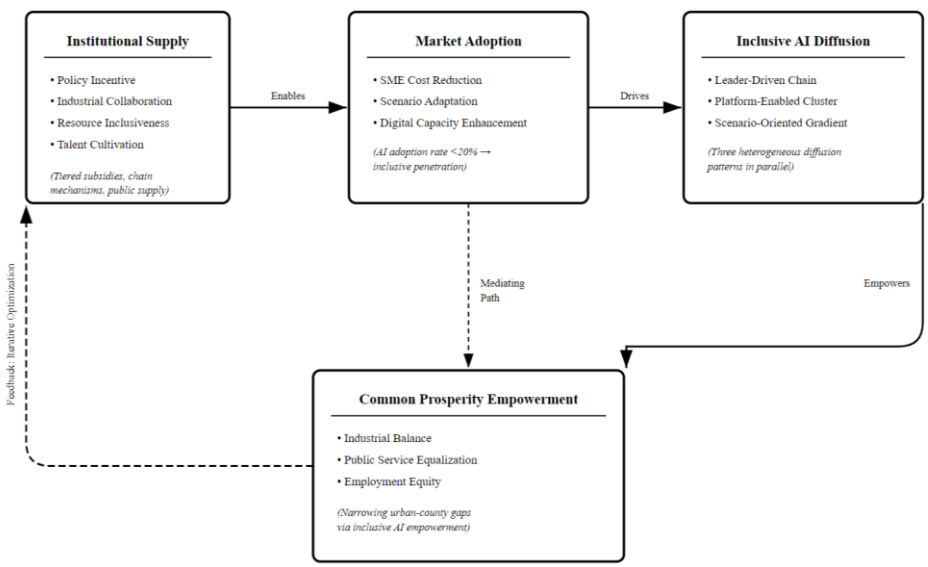


Figure 2. Four-dimensional theoretical framework of county-level inclusive AI diffusion in private economy-dominated regions. The framework illustrates the closed-loop logic from institutional supply through market adoption and inclusive AI diffusion to common prosperity empowerment, with feedback mechanisms driving iterative institutional optimization.

Targeted institutional innovations can effectively break the above constraints and drive inclusive AI diffusion from urban highlands to county lowlands. First, policy

incentive institutional innovation: Tiered financial subsidies and tax incentives reduce the AI transformation cost of county SMEs and grassroots public institutions. Second, industrial collaborative institutional innovation: Build urban-county industrial chain linkage mechanisms to realize the diffusion of urban R&D technology to county manufacturing links. Third, resource inclusive institutional innovation: Open public computing power and urban brain data resources to realize low-cost supply of county AI elements. Fourth, talent training institutional innovation: Carry out customized digital skill training to improve the AI application capacity of county workers and grassroots managers.

Inclusive AI drives regional common prosperity through three core paths. First, industrial balanced development path: Intelligent transformation of traditional county industries and industrial chain collaborative optimization narrow the economic development gap between urban and county areas. Second, public service equalization path: AI remote education, telemedicine, and precise social security break geographical restrictions to realize equal sharing of high-quality public resources. Third, opportunity equity optimization path: AI vocational training and inclusive entrepreneurial services reshape workers' skill structures and balance urban and rural employment and entrepreneurial opportunities. The mediating transmission paths are summarized in Figure 3.

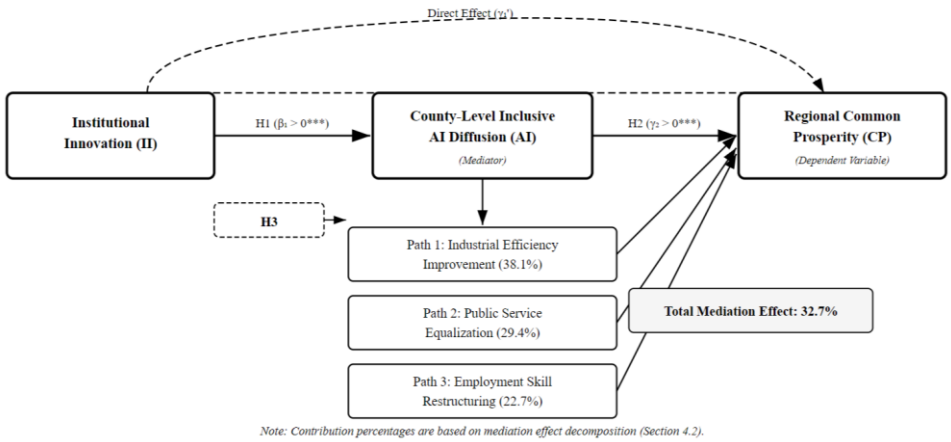


Figure 3. Chain mediation transmission path from institutional innovation to regional common prosperity through county-level inclusive AI diffusion. Three parallel mediating channels are identified: industrial efficiency improvement (38.1%), public service equalization (29.4%), and employment skill restructuring (22.7%), with a total mediation effect of 32.7%. Dashed lines indicate the direct effect path.

2.3. Research Hypotheses

H1: Institutional innovation (policy incentive, industrial collaboration, resource inclusiveness, talent training) significantly promotes the county-level inclusive AI diffusion in private economy-dominated regions.

H2: County-level inclusive AI diffusion effectively promotes regional common prosperity, including balanced industrial development, equal public services, and

equitable employment opportunities.

H3: Inclusive AI diffusion plays a mediating role between institutional innovation and regional common prosperity.

H4: The diffusion effect of inclusive AI presents heterogeneous patterns of leader-driven, platform-clustered, and scenario-gradient in private SME clusters.

3. Research Design

3.1. Research Context and Data Sources

This study takes Wenzhou, Zhejiang Province, as the research sample, which is a typical private economy-dominated region and an important practice area of Zhejiang Common Prosperity Demonstration Zone. The research data are derived from three sources: first, statistical yearbook data of Wenzhou's districts and counties from 2019 to 2024, including economic development, public service, and employment indicators; second, field survey data of 200 private SMEs and 8 county-level public service institutions; third, policy documents, industry reports, and pilot practice data of Wenzhou's AI development and digital inclusive construction.

3.2. Variable Measurement

(1) Dependent Variable: Common Prosperity Level (CP)

Construct a common prosperity evaluation index system covering three dimensions: industrial development balance, public service equalization, and employment opportunity equity, and calculate the comprehensive common prosperity index of each county through entropy weight method.

(2) Core Independent Variable: Institutional Innovation (II)

Measure from four sub-dimensions: policy incentive intensity, industrial collaboration mechanism maturity, public resource inclusiveness, and digital talent training scale, forming the institutional innovation comprehensive index.

(3) Mediating Variable: Inclusive AI Diffusion Level (AI)

Evaluate the county-level inclusive AI diffusion level based on industrial intelligent application penetration, public service AI coverage, and grassroots digital governance intelligence level.

(4) Control Variables

Select regional economic development level, industrial structure upgrading degree, infrastructure construction level, and government governance capacity as control variables to eliminate the interference of exogenous factors.

4. Empirical Results and Analysis

4.1. Benchmark Regression Results

The benchmark regression results verify the effectiveness of the research

hypotheses. First, institutional innovation has a significantly positive impact on common prosperity ($\alpha>0$, $p<0.01$), indicating that optimized institutional arrangements can effectively promote regional inclusive development. Second, institutional innovation significantly improves the county-level inclusive AI diffusion level ($\beta>0$, $p<0.01$), confirming that institutional innovation breaks the diffusion barriers of inclusive AI. Third, after adding the mediating variable, both institutional innovation and inclusive AI diffusion have significant positive effects on common prosperity, and the mediation effect is significant, verifying H1, H2 and H3.

4.2. Mediating Effect Verification

The mediation effect decomposition results show that the contribution rate of inclusive AI diffusion in the process of institutional innovation empowering common prosperity reaches 32.7%, among which the industrial efficiency improvement path contributes the most (38.1%), followed by public service equalization (29.4%) and employment skill optimization (22.7%). It indicates that inclusive AI diffusion is the core transmission mechanism for institutional innovation to bridge regional development gaps.

4.3. Robustness Test

This study conducts robustness tests by replacing variable measurement methods, shortening the sample interval, and eliminating outlier samples. The results show that the core regression coefficients are consistent in direction and significant in statistics, which verifies the reliability of the research conclusions.

5. Typical Diffusion Patterns of County-Level Inclusive AI

Combined with the field practice of Wenzhou's private economy clusters and county-level inclusive AI applications, this study summarizes three differentiated inclusive AI diffusion patterns adapted to private economy-dominated regions, verifying hypothesis H4.

5.1. Leader-Driven Chain Diffusion Pattern

This pattern is dominated by urban leading private enterprises such as Chint and Semir, applicable to clustered traditional manufacturing industries represented by Wenzhou electrical equipment. Leading enterprises take the lead in deploying AI intelligent production, quality inspection, and supply chain management systems, formulate unified industrial intelligent standards, and force supporting SMEs in county areas to carry out synchronous intelligent transformation through industrial chain matching mechanisms. Supported by government industrial policy subsidies, it realizes the full-chain AI penetration from urban R&D links to county manufacturing links. This pattern features high efficiency, strong standardization, and significant industrial synergy effects, which can rapidly improve the overall

intelligent level of county industrial clusters.

5.2. Platform-Enabled Cluster Diffusion Pattern

Aiming at the large number of small and micro private enterprises with weak independent transformation capabilities, this pattern relies on industrial Internet platforms and public AI service platforms to provide lightweight, low-cost AI inclusive solutions such as intelligent design, online marketing, and equipment operation and maintenance. Relying on Wenzhou's supET industrial Internet platform and urban brain data resources, it reduces the AI application threshold of county SMEs through ten-thousand-level computing power leasing and thousand-level intelligent sensor services. Driven by industry associations and university laboratory technical support, it realizes the simultaneous AI popularization and application of numerous scattered small and micro enterprises, with the characteristics of low cost, wide coverage, and strong inclusiveness.

5.3. Scenario-Oriented Gradient Diffusion Pattern

Focusing on county public service and rural revitalization scenarios, this pattern realizes the gradient diffusion of inclusive AI from urban core areas to remote counties and rural areas. In terms of public services, AI remote medical diagnosis systems and intelligent dual-teacher classrooms extend high-quality urban medical and educational resources to underdeveloped counties such as Wencheng and Taishun, solving the problems of insufficient grassroots public service resources. In terms of rural development, relying on the rural revitalization laboratory built by Wenzhou University in county areas, it develops agricultural product AI traceability platforms and dialect intelligent government systems to empower rural digital governance and industrial development. This pattern breaks geographical resource constraints, effectively bridges the urban-rural public service gap, and realizes the equitable sharing of AI technological dividends.

6. Risk Analysis and Countermeasure Mechanism

6.1. Potential Risks of Inclusive AI Diffusion

In the process of county-level inclusive AI diffusion in private economy-dominated regions, there are three potential risks. First, technological monopoly risk: Leading enterprises and platform institutions may form technological barriers, resulting in uneven distribution of digital dividends. Second, data security risk: The cross-regional circulation of grassroots livelihood data and industrial data may trigger privacy leakage and safety hazards. Third,structural employment risk: The intelligent transformation of traditional industries may lead to short-term low-skilled worker unemployment and employment structural imbalance.

6.2. Institutional Optimization Countermeasures

Aiming at the above risks, this study constructs a multi-dimensional institutional guarantee system. First, establish a market supervision and anti-monopoly mechanism to standardize the AI technology sharing and profit distribution mechanism of industrial chains and prevent technological capital monopoly. Second, build a whole-process data security governance system, adopt blockchain desensitization technology for grassroots data circulation, and introduce third-party ethical review institutions to ensure compliant application of AI scenarios. Third, improve the digital skill training and employment security mechanism, build a lifelong vocational training system oriented to industrial AI transformation, and realize the smooth transformation of traditional workers to high-skilled posts.

7. Conclusion and Discussion

7.1. Main Conclusions

Taking the county-level practice of Wenzhou, a typical private economy-dominated region, as the research object, this study systematically explores the institutional innovation mechanism, diffusion patterns, and inclusive growth effects of county-level inclusive AI. The main conclusions are as follows: First, institutional innovation including policy incentives, industrial collaboration, resource inclusiveness, and talent training can effectively break the resource and institutional barriers of county-level inclusive AI diffusion. Second, county-level inclusive AI diffusion significantly promotes regional common prosperity by optimizing industrial structure, equalizing public services, and balancing employment opportunities. Third, private economy-dominated regions form three differentiated inclusive AI diffusion patterns: leader-driven chain diffusion, platform-enabled cluster diffusion, and scenario-oriented gradient diffusion, which adapt to industrial upgrading and public service inclusive scenarios respectively. Fourth, technological monopoly, data security, and structural employment are the main potential risks restricting the sustainable development of inclusive AI, which requires matching institutional optimization and risk prevention mechanisms.

7.2. Theoretical and Practical Implications

Theoretical Implications: This study expands the research framework of digital technology inclusive diffusion, constructs a theoretical paradigm of institutional innovation empowering county-level AI inclusive development adapted to private economy scenarios, makes up for the research deficiency of existing technology diffusion theory in grassroots inclusive scenarios, and provides new theoretical support for the integration of digital economy and common prosperity theory.

Practical Implications: For regional governments, it is necessary to formulate differentiated inclusive AI development policies according to county industrial characteristics and resource endowments, increase inclusive subsidies for SME intelligent transformation, and accelerate the sinking of urban digital resources to

county areas. For private enterprises, they should strengthen industrial chain collaborative innovation, open up technological resources to supporting enterprises, and realize mutual benefit and win-win of industrial cluster upgrading. For universities and scientific research institutions, they should strengthen school-local cooperation, carry out targeted digital talent training and scenario technology research and development, and provide technical and talent support for county-level inclusive AI development.

7.3. Research Limitations and Future Prospects

This study still has some limitations. First, the research sample is concentrated in Wenzhou, and the universality of the conclusion needs to be further verified with multi-region samples. Second, this study focuses on the static mechanism of inclusive AI diffusion, and the dynamic evolution characteristics of long-term diffusion need further longitudinal tracking research. Future research can expand the sample to more private economy-dominated regions, explore the dynamic coupling mechanism between institutional innovation and inclusive AI diffusion, and further discuss the digital dividend sharing system and algorithm equity governance mechanism under the background of AI empowering common prosperity.

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