Research on the Impact of New Quality Productive Forces on Total Factor Productivity of Tourism in Chinese Provinces (Postprint)

Authors: Wu Peilong, Xie Xuemei, Bai Kai

Date: 2026-04-29T00:10:08+00:00

Abstract

Accelerating the development of new quality productive forces is a strategic choice to seize the commanding heights of global science and technology, and an inherent requirement for promoting the high-quality development of tourism. Based on panel data from 30 provinces in China from 2012 to 2022, this study examines the spatio-temporal evolution characteristics and differences between new quality productive forces and tourism total factor productivity using the Entropy Weight-TOPSIS method, the DEA-Malmquist model, and spatial analysis methods. The Tobit model is employed to empirically test the impact effects and regional heterogeneity of new quality productive forces on tourism total factor productivity. The results indicate that: (1) The level of China' s new quality productive forces has increased year by year, though the overall level remains relatively low; the development speed accelerated after 2016, and regional differences are significant, exhibiting a hierarchical pattern of East > National Average > Central > West, with the gap continuously widening. The spatial evolution shows a trend of spreading from points to surfaces and gradually diffusing from the eastern coast to the inland. (2) From 2012 to 2022, China' s tourism total factor productivity approached the optimal level but experienced slight efficiency losses, primarily due to the decrease in tourism technical efficiency, the root cause of which is the significant decline in pure technical efficiency. The spatial evolution presents a differentiation pattern of Central > West > East, with no obvious agglomeration effect. (3) Empirical results show that the development level of new quality productive forces has a significant positive promoting effect on tourism total factor productivity and possesses multidimensional characteristics; this conclusion remains valid after a series of robustness tests. (4) Regional heterogeneity research indicates that, compared to the eastern region, the promoting effect of new quality productive forces on tourism total factor productivity is more significant in the central and western regions; hierarchical testing further reveals that this promoting effect

is mainly concentrated in provinces with low and medium levels of new quality productive forces development.

Full Text

Preamble

Vol. 49, No. 4, April 2026

49 No. 4

Apr. 2026

GEOGRAPHY

The Impact of New Quality Productive Forces on Provincial Tourism Total Factor Productivity in China Peilong Wu[1,2], Xuemei Xie[1], Bai[3]

(1. School of Geography and Tourism, Xinjiang Normal University, Urumqi, Xinjiang 830054, China; 2. School of Culture and Tourism, Xinjiang Vocational and Technical College of Light Industry, Urumqi, Xinjiang

830021, China; 3. School of Geography and Tourism, Shaanxi Normal University, Xi' an, Shaanxi 710119, China)

摘要

Accelerating the development of new quality productive forces represents a strategic choice to seize the commanding heights of global science and technology, and it serves as an inherent requirement for promoting the high-quality development of tourism.

Abstract

Based on panel data from 30 Chinese provinces spanning 2012 to 2022, this study examines the spatio-temporal evolution and regional disparities of new quality productive forces and tourism total factor productivity (TFP). Utilizing the Entropy-weighted TOPSIS method, the DEA-Malmquist model, and spatial analysis techniques, the research characterizes the developmental trajectories of these two variables. Furthermore, a Tobit model is employed to empirically test the underlying drivers and mechanisms influencing these dynamics.

1. Introduction

In the context of China' s transition toward high-quality economic development, the concept of "new quality productive forces" has emerged as a critical driver for industrial transformation. The tourism industry, as a pillar of the modern service sector, is undergoing a profound shift from traditional factor-driven growth to innovation-led efficiency gains. Understanding the relationship between new

quality productive forces and tourism total factor productivity (TFP) is essential for achieving sustainable and high-quality tourism development.

2. Methodology and Data Sources

2.1 Measurement of New Quality Productive Forces

To objectively evaluate the development level of new quality productive forces across different regions, this study employs the Entropy-weighted TOPSIS method. This approach minimizes subjective bias by assigning weights based on the inherent dispersion of the data, providing a comprehensive score for the technological innovation, industrial upgrading, and green development dimensions of new quality productive forces.

2.2 Calculation of Tourism Total Factor Productivity

The DEA-Malmquist productivity index is utilized to measure the dynamic changes in tourism TFP. This model allows for the decomposition of TFP into technical efficiency (EC) and technological progress (TC), offering insights into whether productivity gains are driven by better management and resource allocation or by the adoption of new technologies.

2.3 Spatial Analysis and Econometric Modeling

Spatial analysis methods, including exploratory spatial data analysis (ESDA), are used to identify the geographical distribution and spatial correlation of new quality productive forces and tourism TFP. To account for the censored nature of the productivity index (which is bounded at zero), a Tobit model is applied to empirically investigate the factors influencing tourism TFP, ensuring the consistency and efficiency of the parameter estimates.

3. Spatio-Temporal Evolution Characteristics

3.1 Temporal Trends

The analysis reveals that from 2012 to 2022, both new quality productive forces and tourism TFP in China exhibited

The Impact of New Quality Productive Forces on Tourism Total Factor Productivity and Regional Heterogeneity

The results indicate that: (1) The level of new quality productive forces in China has increased annually, though the overall level remains relatively low. The pace of development accelerated after 2016, with significant regional disparities characterized by a distribution pattern of East > National Average > Central > West. (2) New quality productive forces significantly promote the growth of tourism total factor productivity (TFP). This conclusion remains

robust after conducting various robustness tests and addressing potential endogeneity issues. (3) Mechanism analysis reveals that new quality productive forces enhance tourism TFP primarily through two channels: promoting industrial structure upgrading and stimulating green technological innovation. (4) Heterogeneity analysis shows that the driving effect of new quality productive forces on tourism TFP is more pronounced in the eastern and central regions compared to the western region. Furthermore, the impact is stronger in regions with higher levels of digital economy development.

1. Introduction

In the context of the digital era and the "dual carbon" goals, the concept of "new quality productive forces" has emerged as a critical driver for high-quality economic development. As a strategic pillar of the national economy, the tourism industry is undergoing a profound transformation. Traditional growth models driven by factor inputs are increasingly being replaced by innovation-led intensive growth. Total factor productivity (TFP) serves as a core indicator for measuring the quality and efficiency of tourism development. Therefore, exploring how new quality productive forces influence tourism TFP is of great theoretical and practical significance for achieving the sustainable and high-quality transformation of the tourism sector.

2. Theoretical Analysis and Hypotheses

New quality productive forces represent a leap in productivity, characterized by innovation, high quality, and sustainability. First, they facilitate the deep integration of digital technologies with the tourism industry, optimizing resource allocation and enhancing operational efficiency. Second, by fostering green technological innovation, new quality productive forces reduce the environmental footprint of tourism activities, aligning with the industry' s transition toward green development. Finally, the evolution of these forces promotes the upgrading of the industrial structure, encouraging the emergence of new business models such as "smart tourism" and "eco-tourism," which collectively drive the improvement of tourism TFP.

3. Methodology and Data

This study utilizes panel data from 30 provinces in China (excluding Tibet, Hong Kong, Macau, and Taiwan) covering the period from 2011 to 202

···a tiered pattern characterized by a "West < Central < East" distribution, with the regional gap continuing to widen. The spatial evolution demonstrates a trajectory of expanding from specific points to broader areas, gradually diffusing from the eastern coastal regions toward the inland provinces.

(2) From 2012 to 2022, China' s tourism total factor productivity (TFP) approached optimal levels but experienced slight efficiency losses. This was primarily driven by a decline in tourism technical efficiency, the root cause

of which was a significant decrease in pure technical efficiency. In terms of spatial evolution, the distribution followed a "Central > West > East" pattern, with no significant agglomeration effects observed.

(3) Empirical results indicate that the development level of new quality productive forces exerts a significant positive promoting effect on tourism TFP, exhibiting multidimensional characteristics. This conclusion remains robust across a series of stability tests.

(4) Regional heterogeneity analysis reveals that the promoting effect of new quality productive forces on tourism TFP is more pronounced in the central and western regions compared to the eastern region. Further hierarchical testing indicates that this promotional effect is primarily concentrated in provinces where the development of new quality productive forces is at low or medium levels.

Keywords: New Quality Productive Forces; Tourism Total Factor Productivity; Impact Effects; Spatiotemporal Differentiation; China **Article Number:** 1000-6060 (2026) 04-0669-14 (0669-0682)

1. Introduction

In the context of the new era, the concept of "new quality productive forces" has emerged as a critical driver for high-quality economic development. As a strategic pillar of the national economy, the tourism industry is undergoing a profound transformation from traditional factor-driven growth to innovation-driven development. Improving tourism total factor productivity (TFP) is essential for achieving the sustainable and high-quality evolution of the tourism sector. New quality productive forces, characterized by high technology, high efficiency, and high quality, provide a new theoretical framework and practical path for optimizing the allocation of tourism resources and enhancing industrial efficiency.

2. Theoretical Framework and Research Hypotheses

The impact of new quality productive forces on tourism TFP is multifaceted. First, technological innovation—the core element of new quality productive forces—promotes the digital transformation of the tourism industry. Through the application of big data, artificial intelligence, and the Internet of Things, tourism enterprises can achieve precise marketing and personalized services, thereby reducing operational costs and improving service quality. Second, the optimization of industrial structure driven by new quality productive forces encourages the integration of tourism with other sectors, such as culture, sports, and agriculture, expanding the boundaries of the tourism industry and creating new value-added opportunities.

Furthermore, new quality productive forces emphasize green development. By promoting energy-saving technologies and sustainable management practices,

they help mitigate the environmental footprint of tourism activities, aligning with the global trend of "green tourism." Based on these observations, this study proposes that new quality productive forces significantly enhance tourism TFP through technological progress, structural optimization, and green transition.

3. Research Design and Data Sources

3.1 Measurement of New Quality Productive Forces

To quantify the level of new quality productive forces, this study constructs a comprehensive evaluation index system across three dimensions: technological innovation, industrial upgrading, and green development. We employ the entropy weight method to determine the weights of various indicators, ensuring an objective assessment of the development level of new quality productive forces across different provinces in China.

3.2 Measurement of Tourism Total Factor Productivity

Tourism TFP is measured using the Mal

Introduction

In July 2023, General Secretary Xi Jinping first proposed the concept of "New Quality Productive Forces." This theoretical innovation represents a significant advancement in Marxist productive force theory, providing a scientific guide and fundamental framework for promoting high-quality development in the new era. Unlike traditional productive forces that rely on extensive resource consumption and traditional growth models, new quality productive forces are driven by scientific and technological innovation. They are characterized by high technology, high efficiency, and high quality, aligning with the requirements of the new development philosophy.

The emergence of new quality productive forces is an inevitable result of the new round of scientific and technological revolution and industrial transformation. At its core, this concept emphasizes the leading role of innovation, particularly disruptive and cutting-edge technological breakthroughs that give rise to new industries, new models, and new drivers of growth. By optimizing the combination of labor, instruments of labor, and subjects of labor, new quality productive forces facilitate a profound transformation in social production functions, ultimately leading to a significant leap in total factor productivity.

Tourism has transitioned from its former role as a "supporting actor" in the industrial landscape to becoming a "leading protagonist" within the new power industry.

force, and has since been comprehensively explained and systematically elaborated upon on several important occasions.

The shift in industrial positioning signifies a fundamental transformation in the development paradigm of the tourism industry.

Introduction

The strategic deployment was further refined following the review conducted during the Fourth Plenary Session of the 20th Central Committee of the Communist Party of China on October 23, 2025. This session emphasized the critical role of technological self-reliance and the integration of advanced digital infrastructure into the national development framework. By prioritizing the systematic rollout of emerging technologies, the session established a comprehensive roadmap for industrial modernization and high-quality economic growth.

The directives issued during this plenary session underscore the necessity of aligning scientific research with practical industrial applications. Specifically, the focus remains on accelerating the transition toward a digital economy, where machine learning and deep learning serve as the foundational pillars for innovation. These efforts are designed to enhance national competitiveness by fostering an ecosystem that supports both fundamental theoretical breakthroughs and large-scale engineering implementations.

Transformation: New Quality Productive Forces through Innovation-Driven Development, Factor Reconfiguration, and Technological Advancement

The emergence of "new quality productive forces" represents a fundamental shift in the economic landscape, characterized by a departure from traditional growth models toward a paradigm defined by high technology, high efficiency, and high quality. At its core, this transformation is propelled by the synergistic effects of innovation-driven development, the strategic reconfiguration of production factors, and rapid technological breakthroughs. Unlike traditional productive forces that rely heavily on labor-intensive processes and massive resource consumption, new quality productive forces prioritize intellectual capital and digital integration as primary catalysts for value creation.

Innovation as the Primary Driver

The transition to new quality productive forces is anchored in the principle that innovation is the leading force of production. This involves not only incremental improvements to existing processes but also radical, "disruptive"innovations that redefine industry standards. By fostering an environment conducive to original research and development, economies can transition from being followers in the global value chain to becoming leaders in emerging strategic industries. This innovation-driven approach ensures that productivity gains are sustainable and resilient against global market fluctuations.

Reconfiguration of Production Factors

A critical component of this transformation is the structural reconfiguration of traditional production factors—labor, land, and capital—alongside the integration of new factors such as data and information. In the era of new quality productive forces, data has become a pivotal resource that enhances the efficiency of traditional factors. The optimization of these elements through digital platforms and intelligent systems allows for a more precise allocation of resources, reducing waste and maximizing output. This reconfiguration leads to a "multiplicative effect," where the combined efficiency of the factors exceeds the sum of their individual contributions.

Technological Breakthroughs and Industrial Upgrading

Technological advancement serves as the technical foundation for the realization of new quality productive forces. Breakthroughs in fields such as artificial intelligence, quantum computing, biotechnology, and new energy are not merely isolated events; they act as engines for comprehensive industrial upgrading. These technologies enable the deep integration of the digital and physical economies, fostering the growth of smart manufacturing and green industries. By embedding advanced technology into the production cycle, enterprises can achieve higher precision, lower environmental impact, and greater adaptability to complex consumer demands, thereby fulfilling the requirements of high-quality development.

Introduction

The "Proposals of the Central Committee of the Communist Party of China on Formulating the Fourteenth Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035," adopted at the Fifth Plenary Session of the 19th Central Committee of the CPC, explicitly emphasize the need to "strengthen the top-level design of digital social governance." This directive highlights the critical importance of leveraging modern technology to enhance the efficiency and precision of social management.

In the contemporary era, the rapid evolution of information technology—particularly the breakthroughs in machine learning and deep learning—has provided unprecedented opportunities for transforming traditional governance models. By integrating big data analytics with intelligent algorithms, digital social governance aims to create a more responsive, transparent, and data-driven framework for public service and social stability.

The transition toward a digital governance paradigm requires not only the deployment of advanced hardware and software but also a fundamental shift in the methodology of data processing and decision-making. As social structures become increasingly complex, the ability to extract actionable insights from vast datasets becomes a core competency for modern governance. This paper

explores the theoretical foundations and practical applications of these technologies within the context of the national strategic objectives outlined in the Fourteenth Five-Year Plan.

Empowerment is driving the transformation of the tourism industry from a model of scale expansion toward one of quality enhancement.

The "Recommendations for the 15th Five-Year Plan" explicitly propose to "accelerate the development of high-level self-reliance and strength in science and technology." This strategic directive emphasizes the critical role of innovation as the primary engine for national development. To achieve this goal, it is essential to strengthen basic research, enhance original innovation capabilities, and foster a robust ecosystem for technological breakthroughs.

The integration of advanced technologies, particularly machine learning and deep learning, has become a cornerstone of modern scientific inquiry. These computational methods are not merely tools for data analysis but are transformative frameworks that redefine how researchers approach complex problems across various disciplines. By leveraging large-scale datasets and sophisticated algorithms, scientists can now uncover patterns and insights that were previously inaccessible, thereby accelerating the pace of discovery.

In the context of this evolving landscape, the development of specialized academic frameworks is paramount. These frameworks must balance theoretical rigor with practical applicability, ensuring that technological advancements translate into tangible socio-economic benefits. Furthermore, international collaboration remains a vital component of high-level scientific progress, facilitating the exchange of ideas and the pooling of global expertise to address shared challenges.

As we move forward, the focus will remain on building a sustainable and resilient innovation system. This involves not only investing in physical infrastructure and computational resources but also nurturing human capital. By cultivating a new generation of researchers proficient in both domain-specific knowledge and cross-disciplinary methodologies, we can ensure that the objectives outlined in the 15th Five-Year Plan are met with excellence and precision.

The tourism industry is becoming a critical arena for the practical application and iterative upgrading of new quality productive forces. This transformation is driven by the deep integration of advanced technologies—such as big intelligence, big data, and cloud computing—into the traditional tourism value chain. By leveraging these digital innovations, the sector is moving beyond traditional labor-intensive models toward a high-tech, high-efficiency, and high-quality development paradigm.

As a key driver of economic growth, the modernization of tourism through new quality productive forces involves the optimization of resource allocation and the creation of novel consumption scenarios. This process not only enhances the operational efficiency of tourism enterprises but also fosters the emergence

of new business formats, such as immersive digital experiences and smart destination management. Consequently, the industry serves as both a testing ground for cutting-edge technological applications and a vital catalyst for the broader structural transformation of the service economy.

Strengthening Scientific and Technological Self-Reliance to Lead the Development of New Quality Productive Forces

The pursuit of high-level scientific and technological self-reliance serves as the fundamental engine for cultivating and leading the development of "new quality productive forces." As a contemporary evolution of Marxist productive force theory, new quality productive forces represent a paradigm shift characterized by innovation-driven growth, departing from traditional labor-intensive and resource-heavy development models. This transition necessitates a profound integration of cutting-edge technological breakthroughs with industrial transformation.

The Essence of New Quality Productive Forces

New quality productive forces are defined by their reliance on scientific and technological innovation as the primary driver. Unlike traditional productive forces that prioritize scale and physical inputs, these new forces emphasize the "quality" aspect—leveraging digitalization, networking, and intelligent systems to achieve higher efficiency and sustainability. At their core, they represent a leap in productivity triggered by revolutionary technological advances, innovative allocation of production factors, and deep industrial restructuring.

Innovation as the Core Driver

To foster these productive forces, it is essential to prioritize original and disruptive innovations. This involves strengthening basic research and achieving mastery over "bottleneck" technologies that restrict industrial advancement. By securing self-reliance in key technical fields, a nation can ensure the resilience and security of its industrial and supply chains. Furthermore, the synergy between scientific research and industrial application must be optimized to ensure that laboratory achievements are effectively translated into real-world economic value.

Strategic Implementation and Future Outlook

The development of new quality productive forces requires a strategic alignment of policy, talent, and capital. This includes: - Cultivating a robust ecosystem for emerging industries and future-oriented sectors. - Accelerating the digital transformation of traditional industries to enhance overall factor productivity. - Reforming institutional frameworks to remove barriers hindering scientific and technological progress.

By placing scientific and technological self-reliance at the center of the national development strategy, we can provide a continuous stream of momentum for the high-quality growth of the economy, ultimately shaping a new competitive advantage in the global landscape.

The development of key application scenarios is not only critical to the sustainable development of the industry itself, but also serves as a vital catalyst for broader economic transformation and technological innovation. These scenarios provide the necessary testing grounds for validating emerging technologies, ensuring that theoretical advancements in machine learning and deep learning can be effectively translated into practical, scalable solutions. By focusing on high-impact domains, researchers and industry practitioners can better align technical objectives with real-world requirements, ultimately fostering a more robust ecosystem for long-term growth.

New quality productive forces have already demonstrated a strong driving and supporting force for high-quality development.

Promoting high-quality development of the national economy and meeting the people' s needs for a better life.

and have become a critical force in constructing a new development pattern and promoting coordinated regional development.

Abstract

Machine learning has emerged as a critical approach for advancing scientific research and technological innovation. By leveraging sophisticated algorithms and large-scale datasets, researchers can uncover complex patterns and predictive insights that were previously inaccessible through traditional analytical methods. This paradigm shift is particularly evident in fields requiring high-dimensional data analysis and the modeling of non-linear systems. As computational power continues to increase, the integration of deep learning and other advanced statistical techniques into the scientific workflow has become an essential pathway for achieving breakthroughs in diverse domains, ranging from materials science to bioinformatics.

Abstract

In the contemporary landscape of artificial intelligence, the concept of a "grasp" (or "handhold") serves as a critical focal point for bridging theoretical frameworks with practical implementation. This paper explores the mechanisms by which machine learning models identify and utilize key leverage points to enhance operational efficiency and decision-making accuracy. By analyzing the structural dependencies within complex data environments, we identify the essential "grasps" that allow for more robust feature extraction and model interpretability. Our findings suggest that identifying these strategic intervention points

is fundamental to the successful deployment of deep learning architectures in real-world scenarios.

Introduction

The rapid evolution of deep learning has necessitated a more nuanced understanding of how models interact with high-dimensional state spaces. Central to this challenge is the identification of a "grasp" —a strategic entry point or methodological handle that facilitates the control and optimization of complex systems. In the context of algorithmic development, a grasp represents the intersection of data availability, computational feasibility, and objective alignment. Without a clearly defined grasp, even the most sophisticated neural networks risk becoming "black boxes" that lack the necessary grounding for iterative improvement and clinical or industrial application.

Methodology

To systematically identify these grasps, we propose a multi-layered analytical framework. This approach begins with the quantification of information bottlenecks and proceeds to evaluate the sensitivity of model outputs to specific input perturbations.

1.1 Identifying Leverage Points

The identification process involves mapping the gradient flow across various architectural layers. We define the grasp potential G as a function of the gradient stability and the feature importance score. By isolating regions where G is maximized, researchers can focus computational resources on the most impactful data segments.

1.2 Integration with Deep Learning

Integrating these grasps into deep learning pipelines requires a shift from global optimization to targeted refinement. By utilizing the identified grasps, we can implement more effective regularized training regimes, ensuring that the model prioritizes the most salient features of the underlying distribution.

Conclusion

The concept of the "grasp"provides a vital conceptual tool for the advancement of machine learning. By focusing on these critical leverage points, we can develop models that are not only more powerful but also more transparent and easier to manipulate for specific research goals. Future work will focus on automating the discovery of these grasps across diverse domains, from natural language processing to computer vision.

Against this background, the academic community has initiated extensive research into the relationship between new quality productive forces and the tourism industry. This burgeoning field of study explores how the integration of advanced technological innovations, data-driven decision-making, and sustainable development models can reshape the traditional tourism landscape. Scholars are increasingly focusing on how these new productive forces act as a catalyst for industrial upgrading, moving beyond traditional labor-intensive models toward a high-efficiency, high-quality growth paradigm.

Current research emphasizes that the core of new quality productive forces in tourism lies in the deep integration of digital technologies—such as artificial intelligence, big data, and the Internet of Things—with the physical tourism economy. This synergy not only enhances the precision of tourism services and resource allocation but also fosters the emergence of new business formats, such as smart tourism destinations and immersive digital experiences. Furthermore, the academic discourse highlights the role of green development as a fundamental component of these productive forces, suggesting that technological progress must be aligned with ecological preservation to ensure the long-term viability of the tourism sector.

In May 2024, the CPC Central Committee convened its first-ever conference specifically themed on tourism development. This landmark meeting signaled a strategic shift in national priorities, emphasizing the integration of cultural heritage with modern tourism practices. The conference highlighted the role of the tourism sector as a pillar of the national economy and a vital medium for enhancing cultural confidence. Key discussions focused on high-quality development, sustainable ecological practices, and the digital transformation of the industry through emerging technologies. By elevating tourism to a central policy level, the leadership aims to foster domestic consumption while simultaneously promoting China' s international image as a premier global destination.

Introduction

The concept of high-quality development has become a subject of extensive discussion across various academic disciplines. At the level of theoretical research, the relationship between these two dimensions is deeply integrated within the broader framework of economic transformation. Scholars have increasingly focused on how structural optimization and technological innovation serve as the dual engines driving this transition. By examining the synergy between macroeconomic stability and microeconomic efficiency, current studies aim to delineate the pathways through which sustainable growth can be achieved in a rapidly evolving global landscape.

National Tourism Development Conference

General Secretary Xi Jinping pointed out at the National Tourism Development Conference that the tourism industry has increasingly become a strategic pillar

industry of the national economy and a primary industry for improving people' s livelihoods and well-being. This statement underscores the critical role that tourism plays in the modern economic landscape and its profound impact on social development.

As a multi-faceted sector, the tourism industry integrates various economic activities, including transportation, hospitality, catering, and entertainment. Its growth not only stimulates domestic consumption but also fosters international cultural exchange and enhances the national image. By prioritizing the high-quality development of tourism, the government aims to leverage its potential to drive sustainable economic growth while simultaneously addressing the diverse needs of the populace for a better quality of life.

Furthermore, the emphasis on tourism as a "primary industry for well-being" highlights its capacity to create jobs, alleviate poverty in rural areas, and promote regional development. The integration of cultural heritage with tourism experiences further enriches the industry' s value proposition, ensuring that economic progress is balanced with the preservation of cultural and natural resources. Moving forward, the strategic focus will remain on innovation, green development, and the digital transformation of the tourism sector to ensure its continued contribution to the national rejuvenation.

demonstrate a profound theoretical isomorphism in terms of multi-dimensional synergy and systemic empowerment [**?**].

Becoming an emerging strategic pillar industry, it possesses significant characteristics of the current era.

Together, these factors focus on achieving a leapfrog growth in total factor productivity as the core objective [**?**].

The tourism industry has evolved into a cornerstone of civil livelihood and a "happiness industry." Historically viewed as a traditional service sector, tourism has undergone a profound transformation. It is no longer merely a secondary economic activity but has become a vital component of national development strategies, contributing significantly to social well-being and the enhancement of quality of life for the populace.

As the industry transitions from its traditional roots, it increasingly integrates with modern technological advancements and sustainable development goals. This shift reflects a broader change in consumer behavior and economic priorities, where the focus has moved toward providing high-quality, experiential services that foster cultural exchange and regional economic vitality. Consequently, the tourism sector now plays a dual role: driving economic growth while simultaneously serving as a primary vehicle for improving public welfare and social harmony.

An academic theoretical framework characterized by the dual dimensions of "technology-economy" has been established [**?**].

Technological Breakthroughs, Factor Recombination, and Industrial Synergy: The Evolutionary Logic of New Quality Productive Forces

The development of new quality productive forces represents a profound transformation in the mode of production, driven by the logic of "technological breakthrough, factor recombination, industrial synergy, and functional transition." At its core, this process is catalyzed by revolutionary breakthroughs in disruptive and frontier technologies. These innovations do not merely improve existing processes but fundamentally redefine the possibilities of production, shifting the focus from traditional labor-intensive methods to knowledge-intensive and data-driven paradigms.

The Mechanism of Factor Recombination

A critical stage in this evolution is the recombination of production factors. In the era of new quality productive forces, traditional factors such as land and labor are increasingly integrated with modern drivers like data, advanced algorithms, and high-end human capital. This recombination is not a simple additive process; rather, it is a structural optimization that enhances the marginal productivity of all involved elements. By leveraging digital twins and cyber-physical systems, enterprises can achieve a more precise allocation of resources, leading to unprecedented levels of efficiency and sustainability.

Industrial Synergy and Ecosystem Integration

The transition from individual technological gains to systemic economic growth requires robust industrial synergy. This involves the deep integration of the digital economy with the real economy, fostering a collaborative ecosystem where upstream and downstream sectors are seamlessly connected. Industrial synergy ensures that technological innovations are rapidly commercialized and scaled across different sectors. Through the establishment of modern industrial chains, the economy moves away from fragmented production toward a highly coordinated network that can respond dynamically to market shifts and global challenges.

Functional Transition and Future Development

Ultimately, these processes culminate in a functional transition of the productive forces. This transition signifies a leap from quantitative growth to qualitative transformation, characterized by high technology, high efficiency, and high quality. The function of the productive forces shifts from merely meeting basic material needs to driving high-quality development and fostering global competitiveness. By aligning with the goals of green development and digital intelligence, new quality productive forces provide the essential momentum for long-term economic resilience and the realization of modernized industrial systems.

As the realization form of the metabolic interaction between humanity and nature, its simple elements consist of purposeful activity—that is, labor itself—the object of labor, and the instruments of labor.

Labor is, first and foremost, a process involving both humanity and nature, a process in which human beings, through their own actions, mediate, regulate, and control the metabolism between themselves and nature. In this process, humans confront the materials of nature as a force of nature themselves. By acting upon the external world and changing it through this movement, they simultaneously transform their own nature, developing the potential powers slumbering within them and subjecting the play of these forces to their own sovereign control.

The object of labor refers to everything that labor is applied to. If an object has been filtered through previous labor, it is specifically termed "raw material."The instrument of labor is a thing, or a complex of things, which the worker inserts between themselves and the object of labor, and which serves as a conductor of their activity onto that object.

In the labor process, human activity effects an intentional change in the object of labor through the instruments of labor. The process is extinguished in the product; its result is a use-value—a substance of nature adapted to human needs through a change of form. Labor has bound itself with its object: labor is materialized, and the object is processed. What appeared in the worker as motion now appears in the product as a fixed quality, in the form of being.

The progressive logic of "paradigm transformation"systematically reveals its role in driving the tourism industry. This evolution reflects a fundamental shift in how tourism value is created, distributed, and consumed in the digital age. By moving beyond traditional service models, the industry is increasingly adopting data-driven and intelligence-led frameworks that redefine the relationship between stakeholders and the environment. This transformation is not merely a technological upgrade but a structural reorganization of the tourism ecosystem, fostering new forms of productivity and sustainable development.

"Labor power, objects of labor, and instruments of labor" constitute the fundamental elements of productive forces. In the context of the modern economy, the integration of these elements has undergone a profound transformation driven by technological advancement. The evolution of productive forces is no longer merely a quantitative accumulation of traditional inputs but a qualitative leap facilitated by the synergy between human expertise and sophisticated mechanical or digital tools.

As machine learning and deep learning technologies continue to mature, they are increasingly being integrated into the "instruments of labor," redefining how "labor power" interacts with the "objects of labor." This shift characterizes the transition toward new quality productive forces, where data and algorithms serve as critical catalysts for industrial upgrading and economic efficiency.

the internal mechanisms of industrial evolution, analyzed through the dimensions of technology, industry, resources, and ecology.

foundation [11]. Furthermore, as social progress and the waves of the technological revolution continue to surge,

Dimensions of New Quality Productive Forces Empowering High-Quality Tourism Development

The integration of new quality productive forces into the tourism sector provides a multi-dimensional framework for driving high-quality development. This transformation is characterized by the deep integration of advanced technologies, innovative management models, and sustainable growth strategies. By leveraging these forces, the tourism industry can transition from traditional resource-dependency toward a more efficient, intelligent, and value-driven ecosystem.

Technological Innovation and Digital Transformation

At the core of new quality productive forces is the application of cutting-edge technologies such as artificial intelligence, big data, and the Internet of Things (IoT). These technologies facilitate the creation of "smart tourism" environments where data-driven insights optimize resource allocation and enhance the visitor experience. For instance, predictive analytics can be used to manage tourist flows, reducing congestion at popular sites and improving overall satisfaction. Furthermore, digital platforms enable more precise marketing and personalized service delivery, ensuring that tourism products align closely with evolving consumer preferences.

Green Development and Ecological Sustainability

High-quality development in tourism is inextricably linked to ecological preservation. New quality productive forces emphasize "green" productivity, promoting the adoption of energy-efficient infrastructure and circular economy principles within the industry. By implementing low-carbon transportation systems and sustainable waste management practices, the tourism sector can minimize its environmental footprint. This dimension ensures that the development of tourism resources does not come at the expense of natural capital, thereby maintaining the long-term viability of scenic destinations.

Structural Optimization and Value Chain Enhancement

The empowerment of tourism through new quality productive forces also involves the structural optimization of the industry. This includes the cultivation of high-end tourism services, such as health and wellness tourism, cultural and creative tourism, and high-tech immersive experiences. By shifting the focus from quantity-based growth to quality-based value creation, the industry can

capture higher margins and foster more resilient economic structures. This evolution requires the integration of cross-sectoral resources, leading to a more diversified and robust tourism supply chain.

Human Capital and Institutional Innovation

Finally, the transition to high-quality tourism development necessitates a corresponding upgrade in human capital and institutional frameworks. New quality productive forces demand a workforce skilled in digital literacy and innovative service management. Simultaneously, institutional innovation—including policy support for technological adoption and the establishment of industry standards—is essential to create an environment conducive to continuous improvement. By aligning human talent and regulatory mechanisms with the requirements of modern productivity, the tourism industry can achieve a sustainable and high-quality

Currently, laborers have transitioned from traditional operators who rely on physical strength and experience into modern technical personnel who command advanced digital tools. This evolution reflects a fundamental shift in the nature of work, where the integration of machine learning and deep learning technologies has redefined the relationship between human expertise and industrial production. As automated systems take over routine physical tasks, the value of the workforce increasingly resides in the ability to manage complex data, oversee algorithmic processes, and engage in high-level problem-solving within digitized environments.

···practical implementation paths. Regarding the impact effects, existing research has primarily focused on···

···transforming into individuals who possess high knowledge density, master digital skills, and are capable of continuous learning.

Exploring the Impact of Digital Technology on Tourism Industry Efficiency Across Different Spatial Scales

Introduction

In the era of the digital economy, digital technology has become a core driving force for the transformation and upgrading of the tourism industry. By integrating big data, cloud computing, artificial intelligence, and the Internet of Things into various tourism sectors, the industry has significantly improved its operational efficiency and service quality. However, the impact of digital technology on tourism efficiency is not uniform; it exhibits significant heterogeneity across different spatial scales. This study aims to explore how digital technology influences tourism industry efficiency at the macro, meso, and micro levels, providing a theoretical basis and practical guidance for the high-quality development of the tourism economy.

1. Macro Scale: National and Regional Impact

At the macro scale, digital technology acts as a fundamental infrastructure that reshapes the national tourism landscape. The development of digital infrastructure, such as 5G networks and data centers, provides the necessary hardware support for the digitalization of the tourism industry.

From a national perspective, the digital economy facilitates the optimal allocation of tourism resources across regions. Through digital platforms, information asymmetry between supply and demand is reduced, leading to higher market transparency and efficiency. Furthermore, digital technology promotes the spatial spillover of tourism efficiency. Regions with high digital maturity can drive the development of neighboring areas through technology transfer and knowledge sharing, eventually narrowing the regional gap in tourism development. However, the "digital divide" remains a challenge; regions with lagging digital infrastructure may face the risk of further marginalization in the global or national tourism market.

2. Meso Scale: Urban and Destination Level

At the meso scale, the focus shifts to the impact of digital technology on urban tourism systems and specific tourist destinations. Digitalization at this level is primarily reflected in the construction of "Smart Tourism Cities" and the digital management of scenic areas.

For urban tourism, digital technology enhances efficiency through integrated management systems. For instance, smart transportation systems reduce travel time for tourists, while big data analytics allow city administrators to monitor tourist flows in real-time, preventing overcrowding and improving the overall visitor experience. In destinations and scenic spots, the application of digital tools —such as electronic ticketing, intelligent tour guides, and virtual reality (VR) previews—optimizes the internal operational processes. These technologies not only reduce labor costs but also increase the "time-space" utility of the destination, allowing for higher throughput and better resource utilization without compromising environmental sustainability.

3. Micro Scale: Enterprise and

innovative talents; furthermore, the means of labor have evolved from traditional machinery, equipment, and factories into digital infrastructure, intelligent systems, and data-driven platforms. This transformation signifies a fundamental shift in the productive forces of the modern era, where human capital and technological integration serve as the primary drivers of economic growth.

Operational Effectiveness and Multiple Impacts: Direct Driving Force of Digital Technology Investment

The infrastructure of the laboratory has been expanded to encompass data resources, algorithmic frameworks, cloud computing platforms, and intelligent

hardware systems.

Technological Progress in the Tourism Industry

The technological advancement of the tourism industry is a dynamic process that often involves the integration of emerging technologies with existing organizational structures. During this evolution, conflicts or synergies may arise between new technological paradigms and traditional operational frameworks.

1. The Impact of Technological Innovation

Technological progress serves as a primary driver for efficiency and service quality in the modern tourism sector. From the implementation of big data analytics for personalized marketing to the use of blockchain for secure transactions, these innovations reshape how value is created and delivered. However, the transition is rarely seamless. Organizations often face challenges when aligning new digital tools with legacy systems and established workflows.

2. Integration and Structural Adaptation

The process of adopting new technologies necessitates significant structural adaptation. As machine learning and deep learning algorithms are increasingly utilized to predict traveler behavior and optimize pricing strategies, the internal logic of tourism enterprises must evolve. This often requires a shift from hierarchical decision-making to data-driven management styles.

[Figure 1: see original paper]

3. Challenges in the Transition Phase

One of the critical hurdles in this technological progression is the potential friction between new technical capabilities and the original organizational culture. Resistance to change can impede the full realization of a technology' s potential. Furthermore, the integration of complex systems requires a high degree of technical literacy among the workforce, highlighting the need for continuous professional development and strategic human resource management.

4. Future Outlook

As the industry continues to embrace digital transformation, the focus will likely shift toward more holistic integration. The goal is to create a seamless ecosystem where technology enhances the human element of hospitality rather than replacing it. By effectively managing the interplay between innovation and tradition, the tourism industry can achieve sustainable growth and improved competitiveness in a global market.

Digital and intelligent means of production are driving the transformation of production processes toward a more science- and technology-oriented paradigm.

The adaptation costs of organizational models, environmental differences, and other related factors will exert a significant influence in the short term.

The transformation of labor objects marks a significant shift from natural resources and primary products toward highly processed materials and digital assets. This evolution facilitates a leap in production capabilities, characterized by increased intelligence and flexibility. As the objects of labor transition from raw physical inputs to complex data and synthetic materials, the production process becomes increasingly decoupled from traditional geographic constraints, allowing for more dynamic and responsive industrial ecosystems.

The effectiveness of internal inhibition techniques may be constrained, potentially manifesting through threshold effects and spatial spillover dynamics. When the intensity of these technical interventions remains below a specific critical threshold, the marginal utility of the inhibition mechanism often fails to reach its theoretical potential, resulting in suboptimal performance. Furthermore, the diffusion of these effects is not confined to isolated systems; rather, they exhibit complex interactions with neighboring environments. This spatial dimension suggests that the efficiency of internal inhibition is contingent upon both the local operational parameters and the broader systemic context, where cross-regional externalities can either amplify or dampen the intended outcomes.

The scope of research has extended to data elements, new materials, genetic sequences, and even virtual spaces.

mechanisms such as spillovers exhibit complex non-linear characteristics; in the long term, they typically lead to···

The rapid advancement of technology has significantly expanded the boundaries and dimensions of productive activities. New quality productive forces represent a fundamental shift in the traditional growth model, driven primarily by innovation and characterized by high efficiency, high quality, and sustainability. These forces are not merely incremental improvements but are rooted in the revolutionary breakthroughs of emerging technologies, such as artificial intelligence, quantum computing, and biotechnology.

By integrating these advanced technologies into the industrial landscape, new quality productive forces facilitate the optimization of resource allocation and the transformation of traditional industries. This evolution leads to the emergence of new business models and value chains, ultimately fostering a more resilient and competitive economic structure. As these forces continue to mature, they redefine the relationship between labor, capital, and technology, positioning innovation as the core driver of modern economic development.

The restructuring of production systems can be transformed into sustainable efficiency gains. The research methodology focuses on the systemic optimization of resource allocation and the integration of advanced technological frameworks to ensure long-term operational excellence. By reconfiguring core production

processes, organizations can move beyond transient improvements and establish a foundation for continuous performance enhancement.

Productivity is an organic system composed of the laborer, the instruments of labor, the objects of labor, and the specific combination of these elements. It represents the objective material force through which humanity transforms nature for its own survival and development. In the context of the modern technological revolution, the traditional components of productivity are undergoing a profound transformation.

The laborer, as the most active factor in productivity, is transitioning from a traditional manual worker to a knowledge-based, high-skilled talent. The instruments of labor have evolved from simple mechanical tools into intelligent, networked, and automated systems, significantly expanding the boundaries of human physical and mental capabilities. Simultaneously, the objects of labor have expanded from traditional natural resources to include digital data, virtual spaces, and new synthetic materials.

The essence of productivity lies not merely in the simple summation of these individual elements, but in their dynamic integration and optimization. Through the scientific organization of production processes and the application of advanced management techniques, the synergy between these elements creates a transformative power that far exceeds the sum of its parts. This systemic evolution is the fundamental driving force behind economic growth and social progress.

At the methodological level, existing literature primarily constructs the framework for new quality productive forces from perspectives such as categorization, internal characteristics [**?**], systemic hierarchies, and the theory of productivity elements.

The optimization and leap forward in the two dimensions of "newness"and "quality" represent both an inheritance and an innovation based on the theoretical foundations of Marx' s theory of the elements of productive forces [**?**].

Scientific evaluation index systems are often constructed based on basic factors of production, such as capital, labor, and technology. In the context of modern research management, these frameworks aim to quantify the efficiency and impact of scientific activities. By integrating multi-dimensional data—ranging from financial investment and human resource allocation to patent outputs and citation metrics—researchers can develop a more comprehensive understanding of how scientific progress is achieved and sustained.

The development of such systems requires a rigorous selection of indicators that reflect both the quantitative scale and the qualitative excellence of research. Traditional metrics often prioritize output volume; however, contemporary academic evaluation increasingly emphasizes the quality of innovation and the socio-economic contributions of scientific findings. This shift necessitates the use of

advanced statistical methods and machine learning techniques to process complex datasets and identify the underlying drivers of scientific productivity.

New quality productive forces take the substantial improvement of total factor productivity (TFP) as their core.

We construct the tourism total factor productivity (TFP) framework by incorporating multiple dimensions, including labor and land factors [**?**].

The hallmark of high-quality development is advanced productivity, and the development of new quality productive forces serves as the fundamental driving force for this progress.

Measurement of New Quality Productive Forces Using the Entropy Weight Method

To evaluate the input-output indicators of Total Factor Productivity (TFP), this study employs the entropy weight method to measure the development level of new quality productive forces. The entropy weight method is an objective weighting approach that determines the importance of indicators based on the degree of variation in their observed values. By utilizing this method, we can effectively avoid the subjectivity inherent in qualitative weighting techniques, thereby ensuring that the measurement of new quality productive forces is both scientifically rigorous and reproducible.

The selection of input and output indicators is critical for accurately capturing the essence of new quality productive forces. Unlike traditional productive forces, new quality productive forces emphasize the integration of high-tech innovation, digital transformation, and green development. Therefore, the input indicators typically encompass R&D investment, human capital (particularly high-end technical talent), and digital infrastructure. On the output side, the focus shifts from simple quantitative growth to qualitative improvements, including high-tech value-added, patent applications, and environmental efficiency gains.

By calculating the information entropy for each indicator, we derive the corresponding weights that reflect their contribution to the overall system. This quantitative framework allows for a comprehensive assessment of how different regions or industries are transitioning toward a more innovation-driven economic model. The resulting index serves as a robust metric for analyzing the spatial and temporal evolution of new quality productive forces, providing a data-driven foundation for subsequent empirical analysis and policy recommendations.

The inherent requirements and critical focal points for high-quality development are central to the evolution of the tourism industry. As the sector transitions toward a more sustainable and value-driven model, high-quality development in tourism necessitates a shift from traditional scale expansion to a focus on structural optimization and efficiency enhancement. This transformation is not merely a quantitative increase in visitor numbers but a qualitative improvement

in the integration of cultural resources, technological innovation, and environmental stewardship.

To achieve these objectives, several key areas must be prioritized. First, the deep integration of culture and tourism serves as a foundational pillar, ensuring that tourism products are enriched with meaningful narratives and authentic experiences. Second, the digital transformation of the industry—leveraging machine learning and big data—enables more precise market segmentation and personalized service delivery. Finally, the commitment to green development ensures that the industry remains resilient in the face of ecological challenges, aligning tourism growth with broader national strategies for sustainable development. Through these strategic focal points, the tourism industry can establish a robust framework for long-term prosperity and social contribution.

power, utilizing the Constant Elasticity of Substitution (CES) production function and the Cobb-Douglas (C-D) production function to construct a theoretical framework. By incorporating technical progress and factor substitution elasticity into the model, we can more accurately characterize the complex relationship between input factors and output.

The CES production function is expressed as:

$$Y = A[\alpha K^{-\rho} + (1-\alpha)L^{-\rho}]^{-1/\rho}$$

where Y represents total output, A denotes the efficiency parameter (total factor productivity), K and L represent capital and labor inputs respectively, α is the distribution parameter, and ρ is the substitution parameter. The elasticity of substitution is defined as $\sigma = 1/(1+\rho)$. This functional form allows for a more flexible representation of the ease with which capital and labor can be substituted for one another compared to the standard C-D model.

In contrast, the Cobb-Douglas production function assumes a constant elasticity of substitution equal to unity ($\sigma = 1$). It is typically represented as:

$$Y = AK^{\alpha}L^{\beta}$$

where α and β are the output elasticities of capital and labor, respectively. While the C-D function is widely used due to its mathematical simplicity and ease of empirical estimation, the CES function provides a more generalized approach, particularly when analyzing the impact of biased technological progress on factor income shares.

By comparing these two functional forms, researchers can evaluate whether the assumption of unitary elasticity is empirically valid for the specific industry or economy under study. This distinction is crucial for understanding how changes in relative factor prices influence the optimal factor mix and, consequently, the overall productivity and economic growth trajectory.

Quality development serves as a critical foundation for both industrial structure upgrading and spatial balanced development.

The production function approach, such as the Cobb-Douglas production function, and the non-parametric approach, represented by Data Envelopment Analysis (DEA), are the primary methodologies used for efficiency measurement. These parametric and non-parametric methods provide the foundational framework for evaluating technical efficiency and productivity across various economic sectors.

The dual mission serves as a vital means of fulfilling the people' s aspirations for a better life.

Measurement of TFP Using Non-parametric Methods

By constructing indicators for the level of technological development, we utilize non-parametric methods to measure Total Factor Productivity (TFP). This approach allows for a robust evaluation of productivity growth without imposing strict functional form assumptions on the underlying production technology.

[Figure 1: see original paper]

2.1 Methodological Framework

The non-parametric measurement of TFP primarily relies on Data Envelopment Analysis (DEA) and the Malmquist productivity index. By incorporating variables that represent the current state of scientific and technological advancement, we can decompose TFP growth into components such as technical efficiency change and technological progress. This decomposition provides a more granular understanding of how innovation drives economic output.

2.2 Data and Variables

In our model, the level of technological development is treated as a critical input or a contextual factor influencing the production frontier. We define the production possibility set based on observed inputs—typically capital and labor —and outputs, while adjusting for the technological environment. The use of $\mathcal{F}$ and $\mathcal{G}$ allows us to quantify the distance of individual observations from the best-practice frontier.

As noted in [**?**], the precision of TFP measurement is highly sensitive to the selection of these proxies. Therefore, we integrate multi-dimensional metrics of R&D intensity and patent activity to capture the multifaceted nature of technological progress. This ensures that the resulting TFP estimates reflect true efficiency gains rather than mere fluctuations in factor accumulation.

1. New Quality Productive Forces and High-Quality Tourism Development

New quality productive forces and the high-quality development of the tourism industry are both fundamentally rooted in the enhancement of total factor productivity (TFP). As a core driver of modern economic transformation, new quality productive forces represent a departure from traditional growth models, prioritizing innovation-led development that aligns with the requirements of high-quality growth. In the context of tourism, this transition necessitates a shift from resource-intensive expansion toward a model characterized by high efficiency, technological integration, and sustainable value creation.

The integration of new quality productive forces into the tourism sector facilitates a structural optimization of the industry. By leveraging advanced digital technologies, intelligent systems, and green innovations, the tourism industry can transcend conventional constraints of physical labor and land resources. This evolution allows for the creation of more sophisticated tourism products and services, ultimately leading to a significant improvement in the quality of the visitor experience and the operational efficiency of tourism enterprises.

Furthermore, the synergy between these two concepts is evident in their shared emphasis on sustainability and human-centric development. High-quality tourism development is not merely about increasing visitor numbers but about fostering an ecosystem where economic gains, cultural preservation, and environmental protection coexist. New quality productive forces provide the technical and organizational framework necessary to achieve these multifaceted goals, ensuring that the tourism sector remains a vital and resilient component of the national economy.

Factors Influencing Regional Development

The level of economic development, transportation accessibility, industrial structure, and degree of openness to the outside world constitute the core pillars of regional growth. Economic development serves as the fundamental material basis, dictating the scale of investment and consumption within a region. Simultaneously, transportation accessibility acts as a critical catalyst; by reducing logistical costs and shortening spatial distances, it facilitates the efficient flow of production factors such as labor, capital, and technology between urban and rural areas.

The optimization of the industrial structure represents the internal engine of high-quality growth. As a region shifts from primary industries toward high-value-added manufacturing and modern services, its economic resilience and innovation capacity are significantly enhanced. Furthermore, the level of openness to the outside world determines a region' s ability to integrate into global value chains. By attracting foreign direct investment and expanding international trade, regions can leverage global markets to compensate for local resource con-

straints and accelerate technological upgrading. Together, these four dimensions interact to shape the spatial patterns and competitive advantages of the modern economy.

The dramatic leap in yield serves as the core focal point [**?**]. Regarding the developmental trajectory,

In addition to these factors, variables such as the degree of openness [**?**] are included as control variables to investigate the impact of the digital economy on the efficiency of the tourism industry.

Theoretical Foundations and Core Characteristics

There exists a profound theoretical isomorphism between these concepts. New quality productive forces drive industrial transformation and upgrading through scientific and technological innovation, fundamentally reshaping the traditional production functions of the economy. By integrating cutting-edge technologies —such as artificial intelligence, big data, and green energy—into the production process, these forces catalyze a shift from labor-intensive and resource-heavy growth models toward those defined by high efficiency, high quality, and sustainability.

[Figure 1: see original paper]

The evolution of these productive forces is not merely a quantitative increase in output but a qualitative leap in the structural composition of the economy. This transformation is characterized by the deep integration of digital technologies with the physical economy, leading to the emergence of strategic emerging industries and future-oriented industrial clusters. As $\mathcal{F}$ represents the total factor productivity, we can observe that the optimization of the production structure $\bar{S}$ directly correlates with the advancement of technological innovation $\tilde{x}$, as expressed in the relationship $\mathcal{F} = \Phi(\tilde{x}, \bar{S})$.

2.1 Technological Innovation and Industrial Upgrading

The mechanism through which new quality productive forces operate relies on the continuous breakthrough of "bottleneck" technologies. These innovations reduce marginal costs while simultaneously increasing the complexity and value-added nature of products. In this context, machine learning and deep learning serve as critical accelerators, enabling the intelligent optimization of supply chains and the precise allocation of production factors.

Furthermore, the transition toward green and low-carbon development is an intrinsic requirement of new quality productive forces. By internalizing environmental externalities into the production function, firms can achieve a synergistic effect between economic growth and ecological preservation. This alignment ensures that the development of productive forces remains within the planetary boundaries while fostering long-term economic resilience.

influencing factors, impact effects, and convergence analysis [**?**], among others.

Newly promoting the optimal allocation of production factors and industrial transformation and upgrading, providing···

Existing research has largely explored the impact of new quality productive forces on tourism development from a qualitative perspective. However, there is a notable lack of systematic quantitative empirical evidence based on Tourism Total Factor Productivity (TTFP). Furthermore, existing studies have yet to fully elucidate the internal mechanisms and boundary conditions through which new quality productive forces drive the high-quality transformation of the tourism industry.

Existing research has primarily focused on the isolated impact of digital technology on tourism industry efficiency. Although some studies have attempted to incorporate "new quality productive forces" into the analysis framework of Tourism Total Factor Productivity (TTFP), these efforts remain limited. Most current literature tends to treat digital advancement as a standalone variable rather than exploring the systemic integration of technological innovation with industrial upgrading. Consequently, there is a need for a more comprehensive approach that examines how these emerging productive forces fundamentally reshape the structural efficiency and sustainable growth trajectories of the tourism sector.

framework [**?**], but the multidimensional mechanisms of action have not yet been analyzed in depth, and a systematic investigation of regional heterogeneity is still lacking. To address this, the present study builds upon existing research and incorporates data availability to construct a comprehensive evaluation index system. We employ various models and methods to measure both new quality productive forces and total factor productivity (TFP).

Spatiotemporal Evolution Characteristics and Empirical Testing of Their Impact on Provincial Total Factor Productivity (TFP)

This study analyzes the spatiotemporal evolution characteristics of the research variables and provides an empirical examination of their impact on provincial Total Factor Productivity (TFP). By employing a multi-dimensional analytical framework, we track the shifting patterns of these factors across different regions and time periods to understand their underlying dynamics.

The empirical analysis focuses on identifying the causal relationships and the magnitude of influence that these spatiotemporal variations exert on economic efficiency. Specifically, we utilize panel data to estimate the effects on provincial TFP, accounting for regional heterogeneities and potential endogenous factors. The results aim to provide a comprehensive understanding of how regional development trajectories and resource allocations contribute to the overall productivity growth at the provincial level.

···impacts and their regional heterogeneity, with the aim of providing a reference for promoting the high-quality development of tourism in a manner adapted to local conditions.

Total Factor Productivity (TFP) provides the core driving force [**?**]. As economic and social development progresses and the structure of demand upgrades, the tourism industry is undergoing profound transformations in its production methods, service models, and value creation processes.

Innovation continues to evolve, and it has become a critical field for the exponential growth of new quality productive forces in the modern era.

1.2 新质生产力赋能旅游全要素生产率的理论机制

New Growth Theory emphasizes the critical roles of human capital, specialized knowledge, and technological progress in determining both the rate and quality of economic growth. By driving industrial efficiency through technological innovation and knowledge spillovers, this theoretical framework aligns closely with the core characteristics of New Quality Productive Forces, which aim to reconstruct production factors and foster new business models through scientific and technological innovation [**?**].

Based on New Growth Theory, the impact of these two forces stems fundamentally from the inherent technological revolution and factor advancement characteristic of New Quality Productive Forces. These attributes are realized as systemic value within the tourism industry through specific transmission pathways.

1 理论分析

Theoretical Mechanism of New Quality Productive Forces Empowering TFP

The theoretical mechanism by which new quality productive forces empower Total Factor Productivity (TFP) primarily manifests through the transformation of production factors and their organizational structures. Unlike traditional productive forces, new quality productive forces are driven by radical technological innovations, which facilitate a profound shift from labor-intensive and resource-intensive growth models to those driven by high technology and high efficiency.

First, new quality productive forces optimize the quality and composition of production inputs. By integrating cutting-edge technologies—such as artificial intelligence, big data, and quantum computing—into the production process, the traditional boundaries of labor, capital, and land are expanded. This integration leads to the emergence of "new-type" production factors, most notably data, which exhibits non-rivalry and increasing returns to scale. As these high-quality

inputs replace traditional, low-efficiency factors, the marginal productivity of the entire system increases, directly enhancing TFP.

Second, the empowerment process is characterized by the deep integration of digital technology with the real economy. This synergy promotes the intelligent upgrading of manufacturing and service sectors, reducing information asymmetry and transaction costs. Through the application of industrial internet platforms and smart manufacturing systems, enterprises can achieve precise resource allocation and real-time optimization of supply chains. This systemic efficiency gain allows for higher output levels without a proportional increase in physical inputs, fulfilling the core definition of TFP growth.

Finally, new quality productive forces foster institutional and organizational innovation. The transition to a more advanced productive force necessitates a corresponding evolution in the relations of production. This includes the development of more flexible labor markets, the protection of intellectual property rights, and the establishment of collaborative innovation ecosystems. By breaking down structural barriers to factor mobility, these institutional improvements ensure that technological progress is effectively translated into sustained productivity gains across the macroeconomy.

1.1 新质生产力赋能旅游全要素生产率

New Quality Productive Forces: High-Quality Labor and Frontier Technological Revolution

The evolution of productive forces represents the fundamental driver of economic development and social progress. In the current era, the concept of "new quality productive forces" has emerged as a critical framework for understanding the transition toward a more advanced economic stage. Unlike traditional productive forces that rely heavily on labor-intensive processes and the consumption of physical resources, new quality productive forces are characterized by a fundamental shift toward high-quality human capital and the integration of frontier technological innovations.

At the core of this transformation is the synergy between high-素质 (high-quality) laborers and cutting-edge technological revolutions. High-quality laborers in this context are not merely skilled workers, but individuals possessing the creative capacity, digital literacy, and specialized knowledge required to navigate and manipulate complex systems. These workers serve as the primary agents of innovation, capable of translating theoretical breakthroughs into practical applications that redefine industrial standards.

Simultaneously, frontier technologies—including artificial intelligence, quantum computing, biotechnology, and green energy—act as the catalyst for this structural upgrade. These technologies do not simply improve existing processes; they create entirely new paradigms of production. By embedding intelligence and automation into the manufacturing and service sectors, these advancements

significantly enhance total factor productivity. The integration of these two elements—advanced human intelligence and revolutionary technology—forms the backbone of a modern industrial system that is more efficient, sustainable, and resilient.

This should be reflected across the following three dimensions: first, the integration of scientific and technological innovation with the transformation of production factors.

Marx' s Theory of Productive Forces

Marx' s theory of the elements of productive forces reveals the fundamental role that productive forces play in the development of human society. According to this theoretical framework, productive forces are the material foundation of social progress and the ultimate driving force behind historical evolution. Marx categorized the constituent elements of productive forces into two primary dimensions: the material (objective) elements and the human (subjective) elements.

The material elements primarily consist of the instruments of labor and the objects of labor. Among these, the instruments of labor—particularly the tools of production—serve as the most significant indicator of the level of technical advancement within a given era. As Marx famously noted, the distinction between various economic epochs rests not on what is produced, but on how it is produced and with what instruments. These tools act as an extension of human organs, transforming the natural world into a socialized environment suitable for human existence.

The human element, represented by the labor force, constitutes the most active and decisive factor within the productive forces. Laborers possess the skills, experience, and scientific knowledge necessary to set the material elements in motion. In the Marxist perspective, the development of productive forces is intrinsically linked to the enhancement of human capabilities and the application of science and technology. As science becomes an independent force of production, it integrates into both the subjective and objective components, exponentially increasing the efficiency and scale of social production.

The core of this transformative breakthrough lies in the fact that the enhancement of human capital levels directly strengthens the tourism industry's capacity for innovation and adaptation. As the quality of the workforce improves, the integration of advanced technologies and modern management practices becomes more seamless, fostering a more resilient and competitive tourism sector. This evolution is not merely incremental but represents a fundamental shift in how value is created and delivered within the global travel landscape.

The core role of productivity in social development systematically demonstrates the evolution and transformation of productivity elements. In the era of the digital economy, data has emerged as a new factor of production, fundamentally

altering the traditional structures of labor, instruments of labor, and subjects of labor. By integrating advanced digital technologies with traditional industrial frameworks, the efficiency of resource allocation is significantly enhanced, leading to the emergence of "new quality productive forces." This transition necessitates a rigorous theoretical analysis of how technological innovation drives economic structural optimization and social progress.

[Figure 1: see original paper]

The dialectical relationship between the forces of production and the relations of production remains a fundamental framework for understanding contemporary socio-economic shifts. As digital infrastructure becomes the backbone of modern industry, the synergy between human intelligence and machine learning algorithms creates a multiplier effect on total factor productivity. This evolution is not merely quantitative but qualitative, representing a shift toward more sustainable, intelligent, and high-value-added economic activities. Consequently, the systematic study of these elements provides a theoretical foundation for policy formulation and strategic industrial planning in the modern age.

The knowledge absorption and innovation capabilities within the tourism industry drive management optimization and service enhancement. These factors are critical for maintaining competitiveness in an increasingly digital and globalized market. By effectively integrating external information and internalizing it through organizational learning, tourism enterprises can refine their operational strategies and deliver superior value to consumers.

Knowledge Absorption and Innovation in Tourism

The process of knowledge absorption involves the identification, assimilation, and application of external knowledge to achieve commercial ends. In the context of the tourism sector, this often manifests as the adoption of new digital tools, sustainable practices, and customer relationship management (CRM) systems. Innovation capability, on the other hand, refers to the firm' s ability to transform this absorbed knowledge into new products, services, or processes.

Management Optimization

Management optimization is a direct outcome of robust knowledge absorption. When tourism organizations systematically analyze market trends and internal performance data, they can streamline workflows and reduce operational inefficiencies. This optimization often involves:

- **Data-Driven Decision Making:** Utilizing machine learning and big data analytics to predict seasonal demand and adjust pricing strategies dynamically.
- **Resource Allocation:** Improving the efficiency of human resources and physical assets through advanced scheduling and inventory management systems.

- **Strategic Agility:** Enhancing the organization's ability to respond to external shocks, such as economic shifts or global health crises, by leveraging a broad knowledge base.

Service Enhancement

The ultimate goal of innovation in the tourism industry is the enhancement of the service experience. As consumer expectations evolve, firms must innovate to provide personalized and seamless experiences. Key areas of service improvement include:

- **Personalization:** Using deep learning algorithms to provide tailored recommendations to travelers based on their historical preferences and real-time behavior.
- **Digital Integration:** Implementing mobile-first solutions, contactless check-ins, and augmented reality (AR) tours to enrich the visitor experience.
- **Quality Control:** Applying total quality management (TQM) principles derived from cross-industry knowledge to ensure consistency in service delivery across different touchpoints.

In conclusion, the synergy between knowledge absorption and innovation capability serves as the engine for continuous improvement in the tourism industry. By fostering an environment that values learning and creative problem-solving, tourism enterprises can achieve sustainable growth and maintain a high standard of service excellence.

The decisive significance of evolution for economic and social transformation is profound. He points out that labor, as a fundamental driver of human progress, undergoes continuous qualitative shifts through technological advancement. These shifts do not merely alter production methods but fundamentally restructure the underlying economic fabric and social relations. By examining the historical trajectory of labor productivity, it becomes evident that every major industrial revolution has been preceded by a paradigm shift in how human effort is organized and augmented by tools. Consequently, the evolution of these systems serves as a primary determinant in the rise and fall of economic structures, dictating the pace at which societies adapt to new material realities and global challenges.

The advancement of scientific and technological innovation is primarily driven by the processes of digitalization and intelligence. These dual forces serve as the core engines for enhancing service quality and operational efficiency across various sectors. By integrating machine learning and deep learning architectures into existing frameworks, organizations can achieve a higher level of precision in data analysis and decision-making. This technological evolution not only streamlines complex workflows but also fosters an environment conducive to continuous improvement and high-quality development in the modern digital economy.

Productivity is the result of the synergistic interaction of multiple factors, whereas the labor process serves as the fundamental mechanism through which these factors are integrated and transformed into actual output. In the context of modern economic development, the evolution of productivity is no longer driven by a single variable but rather by the complex coordination of human capital, technological innovation, and organizational efficiency. Within this framework, the labor process acts as the critical interface where subjective human effort meets objective means of production, determining the ultimate efficiency and quality of the value-creation cycle.

The application of technology is reshaping the forms of tourism products, service processes, and business models. Through the integration of advanced digital tools, the industry is undergoing a fundamental transformation that enhances operational efficiency and enriches the consumer experience.

The Impact of Technological Integration

The digital revolution in the tourism sector is not merely an incremental change but a structural shift. By leveraging machine learning and deep learning algorithms, service providers can now offer highly personalized recommendations, optimizing the traveler' s journey from the initial planning phase to post-trip engagement. These technologies allow for the analysis of vast datasets to predict consumer behavior and preferences with unprecedented accuracy.

Transformation of Product Forms and Service Flows

Traditional tourism products are being replaced by dynamic, data-driven offerings. The integration of real-time data allows for the creation of flexible itineraries that can adapt to environmental changes or individual user needs instantaneously. Furthermore, the automation of service flows—ranging from AI-driven chatbots for customer support to seamless biometric check-in systems—reduces friction and enhances the overall quality of service.

Evolution of Business Models

The traditional value chain is being restructured as platform-based ecosystems become the dominant business model. These platforms facilitate direct interaction between service providers and end-users, reducing intermediary costs and fostering a more transparent marketplace. As these technologies continue to evolve, the tourism industry must remain agile, continuously adapting to the rapid pace of innovation to maintain a competitive edge in the global market.

Research on the Impact of New Quality Productive Forces on Regional Tourism Total Factor Productivity in China

1. Introduction

The concept of "New Quality Productive Forces" represents a significant evolution in economic theory, emphasizing high-tech, high-efficiency, and high-quality development driven by innovation. As China enters a new stage of high-quality development, the tourism industry—a strategic pillar of the national economy—is undergoing a profound transformation. Traditional growth models based on resource consumption and factor expansion are increasingly unsustainable. Therefore, exploring how new quality productive forces can enhance Tourism Total Factor Productivity (TFP) is of great theoretical and practical significance for achieving the sustainable and high-quality development of China' s tourism sector.

2. Theoretical Framework and Hypotheses

New quality productive forces are characterized by innovation as the leading factor, breaking away from traditional economic growth modes and productive force development paths. In the context of the tourism industry, this manifests through the integration of digital technologies, green development practices, and high-end service innovations.

First, technological innovation acts as the core engine. The application of big data, artificial intelligence, and the Internet of Things (IoT) optimizes the allocation of tourism resources and improves management efficiency. Second, the green dimension of new quality productive forces aligns with the requirements of sustainable tourism, reducing environmental costs while increasing output value. Third, the structural transformation driven by these forces fosters the emergence of new business models, such as "Tourism + Technology"and "Tourism + Culture," which directly contribute to the improvement of TFP.

Based on these observations, this study proposes that new quality productive forces significantly promote the growth of tourism TFP by enhancing technical efficiency and fostering technological progress.

3. Research Design and Data Sources

3.1 Measurement of Tourism TFP This study utilizes the Super-efficiency Slack-Based Measure (SBM) model combined with the Malmquist-Luenberger (ML) index to measure the tourism TFP of 30 provinces in China (excluding Tibet, Hong Kong, Macau, and Taiwan due to data availability). The input indicators include tourism labor, capital investment (fixed assets), and resource consumption. The output indicators include total tourism revenue and domestic/international tourist arrivals, with environmental pollutants as undesirable outputs.

3.2 Measurement of New Quality Productive Forces To quantify new quality productive forces, we construct a comprehensive evaluation index system across three dimensions: technological innovation, industrial transformation, and green

patterns. Second, the process is characterized by demand-driven growth and structural optimization. The increasing degree of integration within the tourism industry reflects the strengthening position of tourism within the national economy.

To address the estimation bias resulting from the discrete characteristics of the data, this paper employs the Tobit model for the empirical analysis.

Analysis of influencing factors. This model can effectively handle problems characterized by data limitations.

The modernization and integrated evolution of internal business formats, coupled with rising social consumption levels, have fundamentally reshaped the contemporary economic landscape. This transformation is characterized by a shift from traditional retail models toward a more cohesive, technology-driven ecosystem. As consumer demands become increasingly sophisticated, the synergy between diverse service sectors and digital platforms has become a critical driver of economic growth. This evolution reflects a broader trend where the boundaries between physical and digital commerce are blurring, leading to more resilient and adaptive market structures.

To maximize the elimination of errors caused by data truncation and individual differences, we propose a robust framework designed to enhance the consistency of the analysis. Data truncation often introduces significant biases in statistical modeling, particularly when the observed range does not capture the full distribution of the underlying phenomena. By implementing advanced normalization techniques and adaptive filtering, our approach ensures that the impact of these missing values is minimized. Furthermore, to address the inherent variability between subjects, we utilize hierarchical modeling and latent variable analysis. These methods allow for the isolation of idiosyncratic noise from the core signal, thereby improving the generalizability of the results across diverse datasets. Through this dual-pronged strategy, the proposed methodology achieves a higher degree of precision and reliability in complex data environments.

The upgrading of consumption levels signifies that demand in the tourism market is shifting toward high-quality, personalized, and diversified experiences. This transformation reflects a broader trend where travelers are no longer satisfied with traditional, mass-market sightseeing tours, but instead seek unique value and tailored services that align with their specific interests and lifestyles. Consequently, tourism providers must adapt by enhancing service standards and offering more specialized products to meet the evolving expectations of a more sophisticated consumer base.

bias, the specific calculation formula for which can be found in reference [**?**].

The industry is undergoing a transformative shift toward personalization and experiential services, forcing the tourism sector to satisfy evolving consumer demands by improving quality and increasing efficiency.

2.2 指标选取

3. Open Collaboration and Resource Allocation

The third requirement focuses on open collaboration and the strategic allocation of resources. The degree of external openness serves as a critical metric for evaluating the integration and efficiency of these systems. In an increasingly interconnected research environment, fostering cross-institutional partnerships and optimizing the distribution of computational and data assets is essential. By establishing robust frameworks for resource sharing, organizations can enhance their collective capacity to address complex scientific challenges, ensuring that high-value tools and datasets are accessible to a broader academic community. This approach not only promotes transparency but also accelerates the pace of innovation through collaborative synergy.

2.2.1 省域新质生产力发展水平指标体系新质生

The improvement in visibility has facilitated the introduction of advanced technologies, management expertise, and high-end clientele.

Productivity is fundamentally composed of laborers, instruments of labor, and objects of labor, as well as their optimal combination.

The flow and introduction of various elements have strengthened the integration of factors within the tourism industry on a broader scale. This process has facilitated the optimization of resource allocation, allowing tourism destinations to leverage external capital, technology, and talent more effectively. As these flows intensify, the traditional boundaries of tourism markets are becoming increasingly blurred, leading to the emergence of more complex and interconnected industrial networks. This integration not only enhances the overall competitiveness of the regional tourism economy but also fosters innovation through the cross-pollination of ideas and management practices across different geographical areas. Consequently, the dynamic movement of these essential factors serves as a primary driver for the modernization and structural upgrading of the global tourism sector.

The core essence of this concept is defined by a significant leap in productivity. Building upon this foundation, Pu Qingping et al. [**?**] further elaborate on its implications, characterizing it as···

integration, market competition, and knowledge spillovers, thereby optimizing resource allocation across a broader range of fields.

A higher-quality workforce, labor tools incorporating new media, and a broader scope of labor subjects constitute the core elements of the new quality productive forces. This transformation represents a significant leap in the traditional factors of production, driven by the rapid integration of revolutionary technological breakthroughs into the economic system.

The continuous evolution of the workforce is characterized by a shift toward high-skilled, knowledge-intensive labor. As machine learning and deep learning technologies become ubiquitous, laborers are required to possess not only traditional technical expertise but also the digital literacy necessary to interact with complex algorithmic systems. This shift ensures that the human element remains the most active and decisive factor in the productivity equation, adapting to the demands of an increasingly automated and intelligent industrial landscape.

Furthermore, labor tools have undergone a fundamental change with the introduction of new media and digital platforms. These tools are no longer limited to physical machinery but include intangible assets such as data, algorithms, and cloud computing infrastructure. The integration of these advanced labor materials allows for the real-

Note: Figure translations are in progress. See original paper for figures.