

# Research on the Pathways and Mechanisms of Technological Innovation Driving Industrial Upgrading from the Perspective of New Productivity

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**Abstract.** In the era of rapid technological advancements and global economic transformation, the emergence of "new productivity" has become a critical driver of industrial upgrading. New productivity, characterized by the integration of digitalization, intelligence, and sustainability, represents an advanced stage of productivity development. Technological innovation serves as the core force behind this transformation, reshaping traditional industries and fostering the emergence of new industrial systems. This paper explores the pathways and mechanisms through which technological innovation drives industrial upgrading from the perspective of new productivity. By analyzing theoretical foundations and real-world cases, it identifies key factors such as digital transformation, intelligent manufacturing, and sustainable practices. The study also examines the interactions between technological innovation, industrial structure optimization, and value chain enhancement, providing insights into policy-making and strategic development for realizing high-quality industrial growth.

## 1 Introduction

### 1.1 Research Background and Significance

The global economy is undergoing profound changes driven by the Fourth Industrial Revolution, which is characterized by breakthroughs in artificial intelligence (AI), big data, blockchain, cloud computing, and other emerging technologies. These advancements have given rise to "new productivity," a concept that emphasizes the combination of digital, intelligent, and sustainable production capabilities. New productivity not only redefines the factors of production but also reshapes the industrial landscape by fostering innovation-driven growth.

Industrial upgrading, defined as the process of improving industrial structures, enhancing technological capabilities, and increasing value-added production, is essential for achieving sustainable economic development. Traditional industries are under growing pressure to transition toward higher efficiency, ecological sustainability, and digital transformation. Technological innovation has emerged as the central driving force in this process, enabling industries to move up the value chain, optimize resource utilization, and adapt to shifting market demands.

This study explores the pathways and mechanisms by which technological innovation drives industrial upgrading from the perspective of new productivity. By identifying key drivers and analyzing their interactions, the research provides theoretical and practical guidance

for policymakers and business leaders seeking to promote high-quality economic development.

### 1.2 Research Objectives and Questions

The primary objectives of this study are as follows: To define the concept of new productivity and analyze its implications for industrial upgrading in the context of modern economic transformation. To explore the pathways through which technological innovation drives the transformation of traditional industries and fosters the emergence and growth of new industrial sectors. To examine the mechanisms that link technological innovation to industrial structure optimization, resource efficiency, and value chain enhancement. To provide actionable policy recommendations and strategic insights for promoting innovation-driven industrial upgrading, ensuring sustainable and high-quality development.

The research is guided by the following key questions:

What are the defining characteristics and core components of new productivity, and how do they differ from traditional productivity models? How does technological innovation contribute to industrial upgrading across diverse sectors, particularly in balancing modernization and sustainability? What are the key mechanisms through which technological innovation drives industrial restructuring, enhances value chains, and supports sustainable economic growth? By addressing these questions, the study aims to provide a comprehensive understanding of the role of

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technological innovation in advancing industrial upgrading from the perspective of new productivity, offering theoretical and practical insights into fostering innovation-driven development.

### 1.3 Research Significance

The significance of this research lies in its ability to address pressing challenges and opportunities in the context of global economic transformation. As traditional industries face mounting pressures from resource depletion, environmental concerns, and market competition, the integration of technological innovation has become an essential pathway to achieving industrial upgrading. This study contributes to the understanding of how new productivity, characterized by digitalization, intelligence, and sustainability, can serve as a catalyst for reconfiguring industrial structures and creating value in a rapidly changing economic landscape.

Furthermore, the research provides a theoretical foundation for analyzing the interplay between technological innovation and industrial transformation, offering practical insights into how businesses and policymakers can collaboratively foster sustainable growth. By identifying pathways and mechanisms for industrial upgrading, this study also serves as a reference for developing strategies to support the dual goals of economic competitiveness and environmental sustainability. In doing so, it contributes to the broader discourse on achieving high-quality development in the era of new productivity.

### 1.4 Current State of Research at Home and Abroad

The study of technological innovation and industrial upgrading has garnered significant attention both domestically and internationally, with scholars and policymakers recognizing its critical role in driving sustainable economic development in the context of global technological transformation.

#### 1.4.1 International Research Progress

Globally, research on technological innovation and industrial upgrading has primarily focused on the integration of emerging technologies, such as artificial intelligence (AI), big data, and the Internet of Things (IoT), into traditional industries [1]. Scholars in developed economies, particularly in Europe and North America, emphasize the transformative potential of digitalization and intelligent manufacturing in optimizing industrial value chains and fostering innovation ecosystems.

For instance, Porter's value chain theory highlights how technological innovation enhances competitiveness by enabling enterprises to move up the value chain through improved production processes, product differentiation, and the incorporation of advanced services. Particularly in the Fourth Industrial Revolution, studies have explored applications like smart factories and automation systems, which reduce operational costs

while improving efficiency and customization. In addition, sustainability has become an increasingly important focus in international research, with several studies examining how green technologies and circular economy models contribute to industrial upgrading while addressing environmental concerns.

Emerging economies such as those in Southeast Asia and Latin America have focused on leapfrogging strategies, where latecomer nations adopt cutting-edge technologies to bypass traditional stages of industrial development. These studies emphasize how policy support, knowledge transfer, and international collaboration can enable rapid industrial transformation.

#### 1.4.2 Domestic Research Progress

In China, research on technological innovation and industrial upgrading has gained momentum, particularly in the context of national strategies such as "Made in China 2025" and the "Dual Carbon Goals" of carbon peaking and carbon neutrality [2]. Chinese scholars have explored how technological innovation can address structural inefficiencies in traditional industries and support the development of emerging sectors such as renewable energy, advanced manufacturing, and digital services.

Theoretical research in China frequently highlights the role of government policy in fostering innovation, with studies examining the effects of subsidies, tax incentives, and public-private partnerships. Empirical studies have focused on case analyses of specific industries, such as steel, textiles, and electronics, to identify how digital transformation and intelligent manufacturing improve production efficiency, reduce emissions, and enhance global competitiveness.

However, many domestic studies also point out challenges, such as uneven regional development, limited R&D capabilities in small and medium-sized enterprises (SMEs), and the need for stronger intellectual property protection. These barriers hinder the full realization of innovation-driven industrial upgrading, prompting calls for more comprehensive policy frameworks and collaborative innovation platforms.

#### 1.4.3 Research Gaps and Opportunities

While significant progress has been made, gaps remain in both domestic and international research. Globally, studies often focus on advanced economies, leaving limited exploration of how technological innovation impacts industrial upgrading in developing and transitional economies. Domestically, there is a need for more integrative research that combines theoretical frameworks with empirical evidence across diverse industries. Furthermore, the interplay between technological innovation and sustainability goals, particularly in the context of China's dual carbon strategy, requires deeper investigation.

This study aims to address these gaps by providing a comprehensive analysis of the pathways and mechanisms through which technological innovation,

from the perspective of new productivity, drives industrial upgrading. By integrating insights from international research with China's unique industrial context, this research contributes to the global discourse on innovation-driven development while offering practical guidance for policymakers and industry leaders.

## 2 Theoretical Foundations and Framework

### 2.1 The Concept of New Productivity

New productivity represents an advanced stage of productivity evolution, emerging as a response to the limitations of traditional productivity models in addressing the demands of the modern economy. It is characterized by the integration of advanced technologies, innovative business practices, and sustainable development principles into production processes, creating new value through increased efficiency, enhanced decision-making, and a greater emphasis on ecological and social responsibility [3]. As industries face growing pressures from resource constraints, environmental challenges, and evolving market demands, new productivity has become a critical driver of economic transformation and industrial upgrading.

The concept of new productivity is built upon three core components:

**Digitalization:** The application of digital technologies, such as big data, cloud computing, and the Internet of Things (IoT), to optimize processes, improve decision-making, and enhance connectivity across operations. For example, the use of IoT sensors in manufacturing allows enterprises to monitor equipment performance in real-time, reducing downtime and boosting productivity.

**Intelligence:** The integration of artificial intelligence (AI) and machine learning into business processes enables automated decision-making, predictive analytics, and adaptive systems. These technologies allow companies to uncover insights from large datasets, forecast trends, and optimize operations dynamically, leading to greater precision and efficiency.

**Sustainability:** The incorporation of environmental, social, and governance (ESG) principles into production models, focusing on resource efficiency, carbon reduction, and ecological conservation. Practices such as adopting renewable energy and reducing waste in production not only lower environmental impact but also align with growing consumer and regulatory demands for sustainable operations.

### 2.2 Industrial Upgrading and Its Dimensions

Industrial upgrading refers to the process of transforming industries to achieve higher levels of productivity, competitiveness, and sustainability in response to evolving market demands and technological advancements. It is a critical pathway for enhancing economic resilience and fostering long-term growth. Industrial upgrading ensures that industries not only

meet current challenges but also create opportunities for innovation and value creation.

The process of industrial upgrading encompasses the following key dimensions:

**Technological Upgrading:** This involves the adoption and integration of advanced technologies to enhance production efficiency, improve product quality, and reduce costs. Examples include the implementation of automation, smart manufacturing systems, and AI-driven solutions in production processes. Technological upgrading allows industries to remain competitive in increasingly technology-driven markets.

**Structural Upgrading:** This dimension focuses on shifting from low-value-added sectors to high-value-added sectors, such as transitioning from labor-intensive industries to knowledge-intensive ones. It also involves the development of emerging industries, such as renewable energy, advanced manufacturing, and digital services, which are aligned with modern economic trends and sustainability goals.

**Value Chain Upgrading:** This refers to moving up the value chain by enhancing innovation, branding, and service capabilities. By focusing on higher-value activities, such as research and development (R&D), design, and customer-oriented services, industries can differentiate themselves in global markets and achieve greater profitability.

### 2.3 Research Framework

This study constructs a research framework that links new productivity, technological innovation, and industrial upgrading. The framework includes three core components:

**Technological Innovation as the Driving Force:** Examining how advancements in digital, intelligent, and sustainable technologies enable industrial transformation.

**Pathways of Industrial Upgrading:** Analyzing the specific pathways through which technological innovation influences industrial restructuring, value chain enhancement, and sustainability initiatives.

**Mechanisms of Interaction:** Exploring the dynamic interactions between technological innovation, enterprise behavior, and policy environments.

## 3 Pathways of Technological Innovation Driving Industrial Upgrading

### 3.1 Digital Transformation Pathway

Digital transformation is a key pathway through which technological innovation drives industrial upgrading. By leveraging technologies such as big data, IoT, and cloud computing, enterprises can achieve real-time monitoring, predictive analytics, and data-driven decision-making in production processes. For example, in the manufacturing sector, digital twins enable companies to simulate and optimize production lines virtually, reducing costs and improving efficiency.

Digital transformation also fosters the development of new business models, such as platform-based ecosystems and e-commerce networks, which create additional value and enhance market competitiveness. Industries that embrace digital transformation are better positioned to adapt to changing consumer preferences and market trends.

### 3.2 Intelligent Manufacturing Pathway

Intelligent manufacturing involves the integration of AI, robotics, and automation into production processes. This pathway enables enterprises to achieve higher levels of precision, customization, and scalability. For instance, smart factories equipped with AI-driven robotics can automate complex tasks, reduce human error, and enhance productivity [4].

In addition, intelligent manufacturing supports the transition toward mass customization, allowing companies to produce tailored products at scale without compromising efficiency. This approach not only meets diverse consumer demands but also enhances the competitiveness of traditional industries.

### 3.3 Sustainability-Driven Pathway

Sustainability has become a critical focus for industrial upgrading, driven by growing environmental concerns and regulatory pressures. Technological innovation enables industries to adopt cleaner production methods, reduce waste, and improve energy efficiency. For example, renewable energy technologies, such as solar and wind power, are transforming the energy sector, while green chemistry is revolutionizing the chemical industry.

Sustainability-driven innovation also enhances corporate social responsibility (CSR) and aligns businesses with global sustainability goals, such as the United Nations' Sustainable Development Goals (SDGs). Companies that prioritize sustainability not only reduce their environmental footprint but also gain a competitive advantage in markets that value eco-friendly practices [5].

## 4 Mechanisms of Technological Innovation Influencing Industrial Upgrading

### 4.1 Resource Optimization Mechanism

Technological innovation enables enterprises to optimize the use of key resources such as labor, capital, energy, and raw materials, thereby enhancing productivity and sustainability. By integrating advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), and big data analytics, companies can achieve higher precision in resource allocation and utilization [6]. For example, AI-powered predictive analytics can help enterprises forecast demand more accurately, reducing overproduction and minimizing waste. Similarly, IoT-connected devices in

smart factories enable real-time monitoring of energy consumption and machine performance, ensuring that resources are used efficiently and downtime is minimized.

Moreover, resource optimization through technological innovation has significant implications for reducing production costs and environmental impact. For instance, in the recycling industry, automated sorting systems powered by AI and robotics can improve the efficiency of material recovery, reducing the need for virgin raw materials. In agriculture, precision farming technologies that use IoT sensors and drones can optimize water usage and fertilizer application, leading to higher yields with fewer inputs. Such advancements not only enhance economic performance but also contribute to environmental sustainability by lowering carbon emissions and conserving natural resources.

In addition, resource optimization mechanisms driven by technological innovation promote the reallocation of labor from repetitive, low-value tasks to more creative and strategic roles. Automation and intelligent systems can handle mundane operations, allowing workers to focus on innovation, problem-solving, and customer engagement [7]. This reallocation of human capital also supports workforce development, as employees acquire new skills to adapt to technology-driven changes in their industries.

### 4.2 Knowledge Spillover Mechanism

Technological innovation generates significant knowledge spillovers, enabling advancements in one sector or enterprise to benefit others, fueling cross-industry and cross-sectoral industrial upgrading. Knowledge spillovers occur when innovations created in a specific context are transferred, adapted, and applied to other areas, enhancing overall productivity and competitiveness [8]. For instance, breakthroughs in AI technology developed in the IT sector can be widely applied in industries such as healthcare, manufacturing, and logistics, enabling these sectors to adopt cutting-edge solutions for complex challenges.

In healthcare, AI algorithms originally designed for data processing in IT can be used for diagnostic imaging, patient monitoring, and personalized treatment plans, revolutionizing medical practices. Similarly, in manufacturing, AI-powered robotics and automated quality control systems boost production efficiency and product consistency. In logistics, AI and IoT technologies improve supply chain management by enabling real-time tracking, demand forecasting, and route optimization.

The knowledge spillover mechanism also promotes regional and global industrial upgrading. Regions with strong innovation ecosystems, such as Silicon Valley or China's Greater Bay Area, generate technological advancements that diffuse to other regions and industries, driving widespread economic transformation. This diffusion is facilitated by collaboration between universities, research institutions, and enterprises, as well as through international knowledge transfer and technology licensing agreements.

Furthermore, knowledge spillovers encourage the emergence of new industries and the restructuring of traditional ones. For example, the development of renewable energy technologies, such as wind turbines and solar panels, has spurred the growth of green energy sectors while transforming traditional energy industries to adopt sustainable practices. This dynamic interplay between innovation and spillover effects accelerates the pace of industrial upgrading and fosters a more interconnected and innovative global economy.

### 4.3 Policy and Institutional Mechanism

Government policies and institutional frameworks play a pivotal role in creating an enabling environment for technological innovation and industrial upgrading. Well-designed policies that incentivize research and development (R&D), encourage collaboration, and remove barriers to innovation are essential for fostering sustainable economic growth [9].

One of the most important policy instruments is the promotion of R&D investment. Governments can provide grants, subsidies, and tax incentives to encourage enterprises to invest in cutting-edge technologies. For example, many countries have established innovation funds or programs that support startups and small and medium-sized enterprises (SMEs) in developing new products and processes. Additionally, policies that promote public-private partnerships (PPPs) enable collaboration between government agencies, academic institutions, and private enterprises, pooling resources and expertise to accelerate technological breakthroughs.

Institutional mechanisms, such as intellectual property (IP) protection, are equally critical for fostering innovation. Strong IP laws ensure that inventors and enterprises can capitalize on their innovations without the fear of infringement, promoting a culture of creativity and risk-taking. At the same time, open innovation platforms and technology transfer initiatives encourage the sharing of knowledge and resources, enabling industries to benefit from collective advancements.

Policies that support industrial upgrading often include measures to facilitate technology adoption and diffusion. For instance, governments can provide financial support for enterprises to transition to smart manufacturing systems or adopt green technologies. Regulatory frameworks that mandate energy efficiency standards or emissions reductions compel industries to innovate while aligning with sustainability goals.

In addition, institutional mechanisms play a key role in workforce development, ensuring that employees are equipped with the skills required for technology-driven industries. Governments can establish training programs and education initiatives to prepare workers for roles in emerging sectors, such as AI, renewable energy, and advanced manufacturing. By aligning policy and institutional support with technological innovation, governments can effectively drive industrial upgrading while addressing socioeconomic challenges such as unemployment and regional inequality.

## 5 Conclusion

This study explores the pathways and mechanisms through which technological innovation drives industrial upgrading from the perspective of new productivity. Technological innovation, characterized by advancements in digitalization, intelligence, and sustainability, serves as the foundation for transforming traditional industries and fostering the growth of emerging sectors. By analyzing pathways such as digital transformation, intelligent manufacturing, and sustainability-driven innovation, the study highlights the dynamic interactions between innovation, industrial restructuring, and value chain enhancement.

The findings underscore the importance of adopting a comprehensive approach to innovation-driven development. Policymakers and business leaders must prioritize investments in R&D, foster cross-sector collaboration, and create supportive regulatory environments to realize the full potential of new productivity. Future research should focus on sector-specific strategies and global comparisons to further advance understanding in this field, contributing to high-quality industrial growth and sustainable economic development.

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