# The Impact of Artificial Intelligence on the Real and Digital Economy: Opportunities, Challenges, and Future Directions

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**Abstract.** In this era of information technology and big data coexisting, the development of artificial intelligence has become an unstoppable trend, this essay analyses the impact of artificial intelligence on the real economy and the virtual economy by studying the research data and finding information, and at the same time, according to finding information to analyze the growth of the GDP of various countries in recent decades to judge and speculate on the potential and risk of artificial intelligence while citing several particular countries' cases to support the inference.This study argues that AI has promoted the transformation and upgrading of the real economy by optimizing the production process, improving quality control and production efficiency in manufacturing and agriculture. In the digital economy, the application of AI technology has significantly contributed to the development of e-commerce and data-driven business models, expanding the scale of the digital economy. However, the development of AI has also brought challenges such as structural changes in the job market and increased economic inequality.

**Keywords:** AI; Digital Economy; Economic Impact; Technological Transformation

## 1 Introduction

As technology develops quickly, AI has been commonly applied to help with work. AI and such technology have become the most revolutionary strength in the world. AI is mainly used for information searching, statistic collecting, and data analysis. The AI industry is the most important project in various dimensions. Based on the common phenomenon, its effect on the economy will likely be amplified. The market economy consists of two main parts: the real economy and the digital economy, where AI has been used in various industries.

In the real economy, autonomous driving technology has been upgraded by combining software and hardware production with AI. More and more vehicle manufacturers tend to cooperate with AI technology companies to develop unmanned aerial systems jointly. In the manufacturing industry, AI is progressively replacing manual workers, which might lead to a range of issues, such as employment decline,


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which have already caused tension and anxiety among some involved. The revolution promotes people to master the capability of processing digital data.

When it comes to the digital economy, for example, in the same case, the application of big data and cloud computing has promoted the development of relative technology. Autonomous driving systems perform data processing and analysis through the cloud, bringing new growth opportunities to data survival and cloud computing companies. In 2024, the global digital economy continues proliferating, with significant integration into various sectors. It is estimated that the digital economy now accounts for approximately 60% of the global GDP, showing a consistent upward trend, within which the industrial digitalization component has become a significant driver, representing around 86.8% of the total digital economy. This reflects the deepening digital transformation across traditional industries and the rise of new digital-native business models.

In contrast, the remaining 40% of the global GDP is attributed to the traditional physical or real economy, including less digitally integrated sectors or outside the digital sphere. However, it's important to note that these two realms are increasingly intertwined, with ongoing efforts to digitize more aspects of the real economy. This study will discuss the effect of AI on the real and digital economy and analyze its potential.

## 2 AI and AI System

The definition of AI has been constantly altered and revised over the decades of its existence. The universal conclusion is that AI refers to the fringe discipline that integrates knowledge of information theory, psychology, physiology, linguistics, logic, and mathematics based on computer science to create computer systems that can simulate intelligent human behavior. Meanwhile, although AI and AI systems are closely related, they are conceptually different. AI is a discipline or technical field that aims to enable computers to perform tasks that normally require human intelligence. Research on AI covers multiple subfields, including but not limited to machine learning, natural language processing, computer vision, speech recognition, expert systems, etc. AI does not just refer to a specific software or hardware but a capability or method designed to imitate, enhance, or replace human cognitive functions.

AI can be categorized as follows. Narrow AI, which focuses on handling specific tasks, such as voice assistants and image recognition systems; Generative AI, which can theoretically handle any cognitive task like a human and is still in the research phase, examples include ChatGPT or Intelligent Voice Assistants (IVA) such as Siri; Superintelligent AI, which is AI that surpasses human intelligence and is still in the future hypothesis stage.

AI system refers to the specific implementation of AI technology, including a collection of software and hardware. AI system usually consists of multiple departments, such as a data input module, processing module, AI model, decision-making module, output module, etc. The system is designed to implement specific AI

functions and solve specific problems. For example, autonomous driving systems, facial recognition systems, recommendation systems, etc., are all examples of AI systems.

## 3 Appliance and Influence of AI

The growth of AI and industry in the country has gradually increased in the past several years. The national policy framework for artificial intelligence's development route, its application domains, and quantitative analysis have received the majority of scholarly attention. First, taking into account the backing of national policies, debates have been held over the best course for social governance in the AI era and the effects of AI technology on employment and industrial change. In China, for instance, it is crucial to make efficient use of intelligent technology in this age of intelligence to improve the effectiveness of national administration and lessen any adverse consequences AI may have on employment [1]. The AI sector in China is growing steadily in size, the AI service platform is improving, and the northern cities of Shanghai, Guangzhou, and Shenzhen are forming their industrial growth layouts [2].

A specific example of the effect of AI on the real economy is the application of AI in China's manufacturing industry, which is the Haier Group's "Smart Factory" project. Haier has created a highly automated and intelligent manufacturing system by introducing AI technology. The system uses AI for production scheduling optimization, equipment status monitoring, and quality inspection.

AI can monitor every link on the production line during the production process. For example, through intelligent cameras installed on the production line, AI algorithms can automatically identify and detect whether products have quality problems, such as appearance defects, dimensional deviations, etc., thus significantly improving product quality control efficiency. At the same time, AI can also predict failures based on equipment operating data and perform maintenance in advance to avoid production stagnation caused by equipment failure.

In addition, AI is used to optimize production processes. By analyzing historical production data, AI can optimize production scheduling, reduce resource waste, and improve production efficiency. For example, based on order requirements and equipment status, intelligent factories can automatically adjust production plans to ensure that production tasks are completed quickly.

AI optimization at Haier Group has led to significant improvements in manufacturing efficiency. For example, AI-driven process optimization at Haier's interconnected factories has resulted in a 25% increase in profit margins and an 18% improvement in Overall Equipment Effectiveness (OEE). According to the data from industrie40award.com, AI technology has also reduced production lead times by 30% and minimized defects by 20% through real-time data analysis and machine learning algorithms.

These advancements highlight how AI is transforming manufacturing by optimizing production lines, improving quality control, and enabling predictive

maintenance, ultimately contributing to better performance and cost efficiency in the real economy across Haier's operations.

The advantages and increased efficiency that AI may provide to agriculture is another classic illustration of how it is affecting the actual economy. The current strategy for the growth of the agricultural AI economy goes into great depth on the production effects, the primary ones being as follows: Enhance the resilience of agriculture to climate change [3], boost labor productivity in agriculture [4], expand the agricultural sector's geographic reach [5], and raise the quality of agricultural goods by decreasing reliance on environmental and climatic variables, increase agriculture's competitiveness, effectiveness, and investment attractiveness [6].

In terms of concrete examples, SoftBank Robotics, a subsidiary of Japan's SoftBank Group, has used AI as an assistant. They launched an autonomous cleaning robot called "Whiz" that uses AI technology to clean and maintain agricultural facilities. At the same time, SoftBank has also invested in many agricultural technology companies and is committed to using AI to optimize agricultural production. For example, in tomato greenhouse cultivation in Japan, AI technology uses sensors to track crop growth, temperature, humidity, and other environmental parameters at a certain time. The AI system analyzes and automatically adjusts the climate conditions in the greenhouse based on the collected data to ensure that crops grow in an optimal environment. In addition, AI can detect the health of plants, identify diseases and pests, and automatically spray the appropriate amount of pesticides, reducing labor input and improving crop yield and quality.

Apart from the progress in the real economy, AI also contributes to the digital economy. A significant example is the profound impact of AI in e-commerce platforms on the digital economy. Companies such as Alibaba have optimized their recommendation systems through AI technology, allowing users to find the products they are interested in more accurately. These intelligent recommendation systems predict users' purchase intentions by analyzing user's browsing history, purchase records, and social media data, increasing sales conversion rates. This AI-driven recommendation technology enhances consumers' shopping experience and significantly increases the platform's revenue. It is estimated that AI technology has increased Alibaba's sales by more than 20%, which has had an essential impact on the digital economy in China and worldwide. In addition, the application of AI in inventory management, supply chain optimization, customer service, etc., has further promoted the efficiency and scale of the digital economy.

## 4 Implication of AI on Economy

Production has shifted over the last 60 years from conventional inputs to more capital-intensive, information and communications technology (ICT)-based instruments. Production techniques changed with the advent of the Internet, contemporary computers, and artificial intelligence (AI) in the early 1990s. Zeira (1998) presented an economic growth model that incorporated technological advancements that lower

labor inputs but increase capital requirements in line with the emergence of new technologies [7].

In a cross-country panel dataset, estimation findings show that AI has a positive and significant influence on long-run economic development. Additionally, the impact of AI on growth is greater than the total number of patents. Additionally, for advanced economies as well as the later half of the projection period, AI's contribution to growth is more substantial.

Research reports by consulting firms such as McKinsey & Company and Pricewaterhouse Coopers predict that AI technology will contribute up to $15.7 trillion to global GDP by 2030. Over the past decade, AI's direct contribution to GDP growth has gradually emerged, especially in countries highly dependent on technological innovation, such as the United States and China, where AI-driven GDP growth rates are significantly higher than in other countries.

The descriptive statistics of the panel data, which span ten periods with 5-year intervals between 1970 and 2019, are shown in Table 1 in accordance with Gonzales's study [8]. The dataset utilized is an imbalanced panel data due to problems with data availability, as seen by the differences in the number of groups (n) and observations (N) across variables.

**Table 1.** 5-year intervals between 1970 and 2019.

| Variable | Advanced economies | Less advanced economies |
|---|---|---|
| Real GDP per capita (USD), 5-year average | 34,371.61 | 2637.98 |
| Real GDP per capita growth rate (%), 5-year average | 1.10 | 1.39 |
| AI patents per million people | 290.95 | 6.21 |
| Total patents per million people | 27,876.77 | 785.32 |
| N | 703 | 1467 |
| n | 91 | 165 |

**Table 2.** Overview of economic performance metrics.

| Variable | N | n | Mean | Std. Dev. |
|---|---|---|---|---|
| Real GDP per capita (USD) | 2080 | 208 | 11,990.25 | 20,181.72 |
| Real GDP per capita growth rate (%) | 1936 | 208 | 1.30 | 3.55 |
| AI patents per million people | 2165 | 217 | 98.14 | 475.69 |
| Total patents per million people | 2165 | 217 | 9532.16 | 31,989.98 |
| Population | 2170 | 217 | 25,300,000 | 105,000,000 |
| Population growth rate (%) | 2163 | 217 | 1.35 | 1.32 |
| Gross capital formation per capita | 1927 | 207 | 2809.10 | 4658.01 |
| Gross capital formation per capita growth rate (%) | 1924 | 207 | 1.41 | 8.10 |
| Government expenditure per capita | 1925 | 207 | 2308.52 | 3692.08 |
| Government expenditure per capita growth rate (%) | 1923 | 207 | 1.45 | 5.07 |
| Human capital index | 1387 | 145 | 2.19 | 0.73 |
| Human capital index growth rate (%) | 1386 | 145 | 0.77 | 0.58 |

| | | | | |
|---|---|---|---|---|
| Trade ratio to GDP (%) | 1839 | 196 | 76.45 | 58.56 |
| Inflation (%) | 1928 | 207 | 2.86 | 5.34 |

Across the nations in the sample, five-year growth rates had an average of 1.30% and a standard deviation of 3.55.

Due to the convergence effect, high-income nations should logically have slower growth rates. The following calculations use the 5-year average real GDP per capita variable from the preceding period in order to account for this effect. Real GDP per capita during a five-year period is USD 11,990.25. The standard deviation was quite large due to the presence of both positive and negative outliers. The dataset's estimated five-year real GDP per capita growth rates vary by country and time period, from - 24.52% to 23.59%.)

Table 2 provides an overview of economic performance metrics, including real GDP per capita and GDP per capita growth rates, as well as technical advancements in AI and total patents by economic development level [8]. This is in line with Kim and Lee's (2015) definition, which states that nations in an advanced development stage are those whose real GDP per capita is more than $10,000 USD [9]. Less developed nations fall under this category if their real GDP per capita is below the cutoff.

Gonzales's study indicates that high-income nations produce more technology than lower-income nations do in terms of patents per million inhabitants [8]. The dataset comprises 165 nations, with a slightly higher average real GDP per capita growth (1.39%) in the less developed economy category. The findings show that long-term economic development is driven by innovation in AI. One explanation for AI's beneficial impact across businesses may be its broad applicability. Manufacturing, ICT, transportation, banking, and healthcare services may all use AI systems [10]. The manufacturing industry benefits from self-learning and monitoring as it improves accuracy and makes better use of physical capital, which lowers errors and delays [11]. Modern and useful AI solutions, including speech recognition and voice-to-text software, enable companies to interact with clients instantly, resulting in a rise in the number of customer transactions [10]. Financial systems may use AI technology to identify fraudulent activity and stop loss and theft [12, 13]. Furthermore, traffic flow, which is well recognized to more effectively create negative externalities, may be analyzed and managed by predictive modeling using AI [10, 14].

## 5 Potential and Risk

Over the past decade, AI technology has had a significant impact on the GDP of countries around the world. The rapid development and widespread application of AI are gradually changing the global economic landscape. These are the few key aspects of AI's impact on GDP.

### 5.1 Increased Productivity

Automation and optimization. AI dramatically improves business productivity by automating production processes, optimizing supply chain management, and improving resource efficiency. Many industries, such as manufacturing, logistics, and

agriculture, have achieved higher production efficiency and lower costs by applying AI technology.

Data analytics and decision support. AI helps businesses extract valuable insights from large amounts of data, improving the accuracy and speed of decision-making. This data-driven approach to decision-making has become the standard in many industries, especially in finance, healthcare, marketing, and more.

### 5.2 Innovation Drives growth

They are emerging industries and markets. AI has given rise to many emerging industries, such as autonomous driving, smart home, robotics, etc., which are becoming new economic growth points. In addition, AI technology has also promoted the transformation and upgrading of traditional industries and driven the innovation and development of the overall economy.

Entrepreneurship and investment. Startups and technological innovations in AI have attracted a large amount of venture capital, which not only directly promotes the growth of related enterprises but also indirectly drives the development of other related industries, forming a new economic ecosystem.

### 5.3 Changes in The Labor Market

Restructuring of the employment structure. AI technology has led to the automation of some low-skilled jobs, thereby reducing the demand for these jobs. However, AI has also created many highly skilled, high-value-added jobs, such as AI development, data science, machine learning engineers, etc. This change in the employment structure has had a complex impact on the economy, with both positive and challenging effects.

### 5.4 Enhancement of Global Competitiveness

National competitiveness. Some countries have significantly improved global competitiveness by investing heavily in AI technology and related infrastructure. For example, the leading position of countries such as China and the United States in AI has not only boosted domestic GDP growth but also increased the influence of these countries in the global economy.

### 5.5 Rising Inequality

Economic inequality. While AI technology has brought economic growth, it has also exacerbated economic inequality between and within countries and developed countries, and firms with a strong technology and capital base benefit more. In contrast, less developed countries and regions may be at risk of being further marginalized.

## 6 Conclusion

To summarize, the impact of AI on global GDP is multifaceted, bringing significant economic growth as well as triggering new economic challenges. In the real economy, AI has driven the transformation and upgrading of traditional industries such as manufacturing and agriculture by boosting productivity, optimizing production

processes, and improving quality control, significantly increasing the competitiveness and effectiveness of these industries. Meanwhile, in the digital economy, AI has promoted the rise of new business models and the digital transformation of traditional industries through technologies such as big data and cloud computing, further expanding the scale and influence of the digital economy.

However, the rapid development of AI has also brought about structural changes in the labor market and increased economic inequality. The automation of low-skill jobs has reduced the demand for these jobs, but at the same time has created a large number of high-skill, high-value-added jobs. This shift in the structure of employment has had a complex impact on the economy, both positive and challenging. In addition, the spread of AI technology has made the economy more dependent on countries and firms with a strong technology and capital base, potentially further exacerbating economic inequality between and within countries.

In the future, as AI technology develops further, its far-reaching impact on the global economy will become more evident. Countries should actively respond to this technological change and make full use of the opportunities brought about by AI, while at the same time effectively addressing the risks and challenges that may arise, so as to ensure their competitiveness and sustainable development in the global economic landscape.

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