

New Milestone Achievements in China's Industrial Transformation and Upgrading

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Abstract: *In recent years, China has steadily advanced high-quality economic development, moving from “made in China” to “invented in China”, and scoring new milestones in industrial transformation and upgrading. In terms of resource endowment structure, China has succeeded in bolstering innovation investment and capabilities, as well as converting its demographic dividend into a talent dividend, propelling it into the ranks of leading nations in terms of new infrastructure capacity. China has made groundbreaking progress in 5G, deep ocean, aerospace, transportation, energy, and other critical sectors. China has achieved a rapid expansion in the manufacturing of emerging high-end products, becoming the world's largest robotics market. In terms of industrial structural transformation, China's economy has moved into a service-based development stage, with producer services accounting for a rising share. Technology-intensive and knowledge-intensive services have thrived, high-tech sectors have served as vital economic growth drivers, and integration of the primary, secondary, and tertiary industries, as well as the digital and real economies, has emerged as a prominent trend. The digital economy is growing fast in terms of scale and penetration. “Digital factor×” and “AI+” applications are accelerating industrial upgrading, spawning new business models like smart manufacturing, e-commerce, and online sales. In terms of the green economy, China has initially created a green modern industrial system, transforming itself into a global powerhouse of new energy goods, with renewables accounting for the vast majority of its newly installed generation capacity. In terms of industrial internationalization, high-tech products have made up the bulk of China's exports, China has emerged as a key source of outward direct investment, and the focus of its industrial internationalization has shifted from “going global” to “integrating locally”.*

Keywords: *Industrial transformation and upgrading, milestones, critical frontier technologies, digital economy, green economy*

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In 2010, China surpassed Japan in terms of GDP to become the world's second-largest economy. In the same year, China overtook the United States in terms of manufacturing value added, becoming

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the world's largest manufacturing nation. Since then, China has maintained its status as the world's second-largest economy and largest manufacturing hub. In recent years, China has been steadily advancing high-quality economic development, shifting from “made in China” to “invented in China”, and significantly accelerating industrial transformation and upgrading with milestone achievements. “Invented in China” has grown in strength, as evidenced by the transformation of China's factor endowment structure, new breakthroughs in critical frontier technologies, new levels of emerging high-end products, new stages of industrial structure sophistication, new dynamism from the digital economy, new miracles created in the green economy, and new strides in industrial internationalization.

1. Step Change in China's Factor Endowment Structure

1.1 Ramping up Innovation Spending and Capacity

Between 2012 and 2023, China's total R&D spending climbed from 1.03 trillion yuan to 3.33 trillion yuan, which resulted in a rise in R&D spending intensity from 1.98% to 2.64%. Basic research expenditures as a percentage of total R&D spending also increased, from 4.8% to 6.65% (see Figure 1 and Figure 2). China is ranked 13th in the world in terms of R&D spending intensity, higher than the European Union (2.2%) but lower than the average of OECD countries (2.7%) (Fan, 2023). In 2023, China licensed 921,000 invention patents for the entire year, with 4.015 million valid domestic invention patents, making it the first country in the world with over 4 million patents. China's ability to innovate has grown dramatically in recent years. With 2015 as the base period, China's innovation index reached 155.7 in 2022, with the four innovation sub-indices for innovation environment, input, output and effectiveness standing at 160.4, 146.7, 187.5, and 128.2 respectively (National Bureau of Statistics, 2023a). According to the World Intellectual Property Organization (WIPO), China has risen in importance in the global innovation scene, placing 11th in the world on the innovation index. This makes China the only developing country to rank in the top 15 on the list. China's innovation index ranking has risen for ten consecutive years at the fastest pace among the 36 medium-high income economies (Xinhua News Agency, 2023).

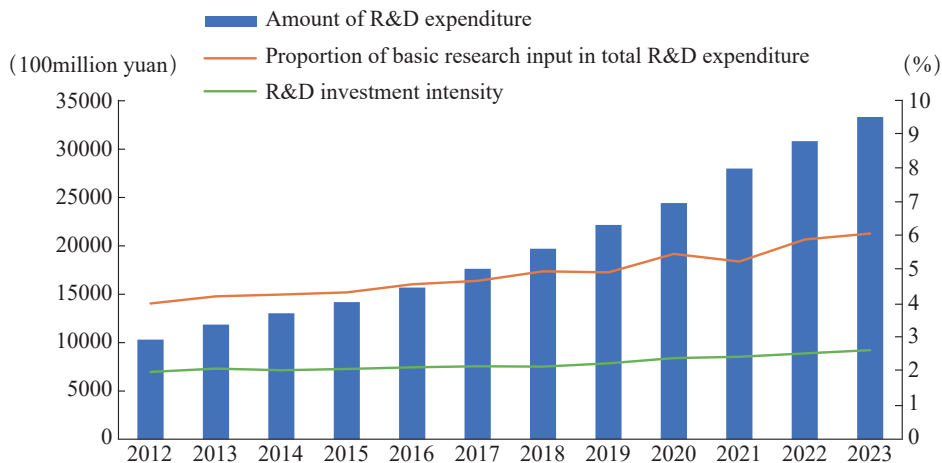


Figure 1: R&D Investment in China from 2012 to 2023

Source: Compiled from National Bureau of Statistics data.

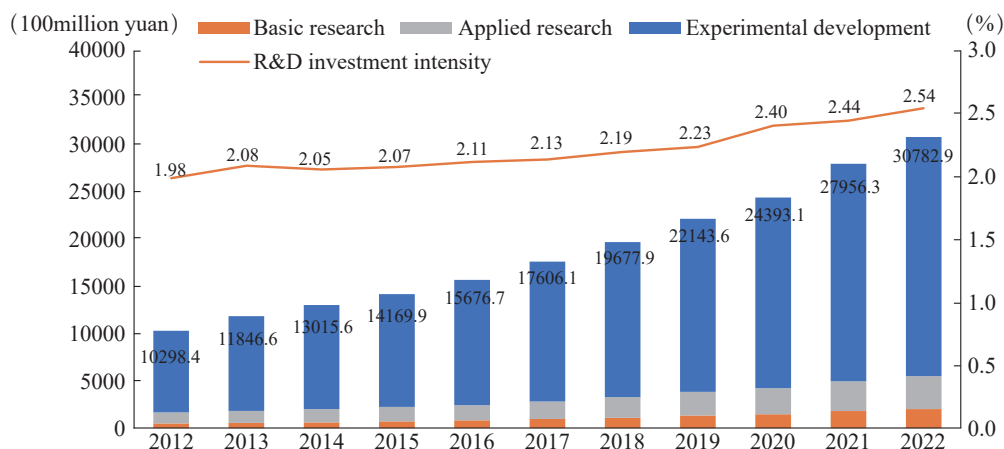


Figure 2: Scale and Structure of Innovation Investments and Changes in Investment Intensity in China from 2012 to 2022

Source: Compiled based on the *Statistical Communiqué of the People's Republic of China on Science and Technology* (2012-2022) and the *Statistical Communiqué of the People's Republic of China on the 2023 National Economic and Social Development*. The data on scale structure for 2023 is missing.

1.2 Qualitative Transition from Demographic Dividend to Talent Dividend

From 2012 to 2022, China's postgraduate student enrollment grew from 589,702 to 1,242,500 persons, while the number of R&D personnel surged from 3.247 million to 6.354 million. Over the past decade, China's cultivation and employment of highly qualified professionals has doubled. In 2023, the average length of education for China's working-age population climbed to 11.05 years, while the average length of education for China's new workforce increased to 14 years, and the number of college graduates reached 240 million. With these accomplishments, China has the world's largest pool of human resources, technologists, and R&D personnel, converting its demographic dividend into a talent dividend (Sheng, 2024). The unremitting supply of human capital provides strong intellectual support for long-term economic development.

1.3 Developing New Infrastructure at the Forefront of the Global Infrastructure Renewal

By the end of 2023, China had 159,000 km of railway in operation, including 45,000 km of high-speed rail. China is the world leader in communication and digital infrastructures, including 5G and quantum communication, and is doubling down on artificial intelligence (AI), cloud computing, and other technological infrastructures. It also leads in industrial Internet, smart transportation networks, and other integrated infrastructures. In 2022, China's total computing power reached 302 eflops (1 eflop is equal to 1 quintillion (10^{18}) floating-point operations per second), ranking second in the world with a 33% global share, after annual expanding by more than 50% in two consecutive years. China's five national top nodes, including Beijing, Shanghai, Wuhan, Chongqing, and Guangzhou, as well as two catastrophe backup nodes in Nanjing and Chengdu, have all gone operational, leading to a nationwide industrial Internet system. Secondary nodes support over 240,000 firms across 45 national economic sectors, including more than 85% of industrial categories across all provinces, autonomous regions, and municipalities. Furthermore, China has seen the emergence of over 240 influential industrial Internet platforms and 28 cross-sector platforms, connecting more than 80 million devices from 1.6 million industrial enterprises. Across the country, over 4,000 "5G plus industrial Internet" projects have been completed, with over 7,000 more under construction. They work together to facilitate data sharing and

resource coordination between diverse manufacturing processes, as well as upstream and downstream supply chains, accelerating corporate digital transition.

2. New R&D Breakthroughs for Critical Frontier Technologies

In recent years, China has adopted an innovation-driven development strategy, focusing on basic and applied research, as well as the development of essential core technologies. As a result of these efforts, China has made great strides in the development of high-end equipment such as fourth-generation nuclear power plants, gas turbines, and aircraft engines, as well as key sectors such as chips, 5G, deep ocean, aerospace, transportation, and energy.

2.1 Major Technological Advancements in Chips, 5G, and Quantum Computing

Breaking free from foreign technology monopoly, Huawei has developed the Kirin 9000s processor on the 7 nm node, improving performance to match 5 nm chips through architectural innovation and higher transistor density. Each iteration of the Harmony operation system has brought fresh improvements. China has built 3.377 million 5G base stations and 23.02 million kilomega ports, as well as commercially deployed customized 5G base stations and 5G lightweight technologies. Breakthroughs in industrial-grade 5G processors, modules, and gateways have resulted in three international and 90 national standards. The Jiuzhang III photonic quantum prototype computer has made world records in photonic quantum information technology and quantum computing performance. It can compute the most complex Gaussian boson sampling in one microsecond, a task that would take over 20 billion years for the world's current fastest supercomputer "Frontier" to complete.

2.2 Leading the World for Aerospace Technology

In 2023, China's Shenzhou 16 and 17 manned spacecraft were successfully launched and docked with the Tiangong space station. This feat marks China's ability to carry out crewed missions for in-orbit rotations and scientific experiments regularly. China has reached internationally advanced levels for environmental control and life support system (ECLSS), and improved the guidance, navigation and control (GNC) technology for space rendezvous and docking. China has completed in-orbit tests of over 20 models of radiation-resistant space station processors for their performance at extreme temperatures. After 276 days of in-orbit flight, China's reusable spacecraft returned to the designated landing site, completing the test flight. The Long March 5 carrier rocket marks China's breakthroughs in large-diameter module-rocket connection and separation technology, large payload fairing separation technology, and precise deviation control technology for high-thrust direct injection orbit. It has raised China's payload capacity above 22 tons for low-Earth orbit.

2.3 Setting New Records for Polar, Deep Ocean, and Offshore Explorations

In January 2023, China's independently developed deep-sea manned submersible Fendouzhe (Striver) undertook a scientific voyage near Antarctica, plunging to a maximum depth of 10,909 meters below the sea surface. This is China's first submersible dive operation in the deep oceans near the polar region. Mengxiang (Dream), a 33,000-ton vessel capable of traveling 15,000 nautical miles, concluded its first trial voyage in December 2023. It is China's first independently designed and constructed ultra-deep-water research and ocean drilling vessel. It has the world's largest and most comprehensive onboard laboratory and most advanced information system, and it can operate in globally unrestricted maritime zones and drill depths of up to 11,000 meters.

2.4 Making Advances in Maritime, Land, and Air Transportation

The C919, China's first midrange narrow-body trunk-line commercial passenger aircraft, successfully completed its inaugural flight. The aircraft, with its superior technological performance and manufacturing lines, has boosted China's global influence and competitiveness in the civil aviation industry. The delivery of China's first large cruise ship, "Adora Magic City", demonstrates China's ability to manufacture large cruise ships, huge LNG carriers, and aircraft carriers at the same time. In addition, China's 600 km/h high-speed magnetic levitation test vehicle completed a successful test run, and the country's first 350 km/h cross-sea high-speed railway between Fuzhou and Xiamen began service. Advances have been made in automotive processors, all-solid-state batteries, and advanced autonomous driving systems.

2.5 Making Progress in A Diverse Range of Clean Energy Projects

China's independently developed Experimental Advanced Superconducting Tokamak (EAST) has achieved notable outcomes in a variety of experiments, including large-current and high-confinement mode operation control for plasma currents exceeding 1 million amperes, injection coupling via a high-power heating system, and advanced divertor configuration. The Baihetan Hydropower Station, the world's largest and most advanced hydropower project, has begun operations. It has 16 hydropower turbines, each with a capacity of 1 million kw, which is the world's largest single-unit capacity. The successful creation of China's first 300MW compressor and expander represents a new era in compressed air energy storage (CAES) technology.

3. New Level in the Manufacturing of Emerging High-End Products

China is the world's largest industrial powerhouse, with the most complete industrial system. It is the only country with all of the United Nations industrial classification system's 41 industrial sectors, 207 categories, and 666 product sub-categories, ranking first in terms of industrial output capacity for 13 years in a row and accounting for more than 30% of the world's total (Chen, 2024). China's complete industrial system and massive manufacturing capacity provide an inexhaustible catalyst for the development of emerging high-end products.

3.1 New Product Manufacturing Has Expanded Rapidly

Between 2015 and 2022, China's new product sales revenue climbed by 11.7% on an annualized basis. In 2022, China's large industrial enterprises reported a new product sales revenue of 32.8 trillion yuan, accounting for 24.6% of their total business revenue, up 11.0 percentage points from 2015. Domestic new product sales revenue was 9.9 trillion yuan, while the revenue of sales of international-level new products reached 3.5 trillion yuan, representing a 77.8% and 60.9% increase over 2016, respectively (NBS, 2023b).

3.2 Smart Products Have Mushroomed

Digitalization and intelligence, together with rising consumer demand, have resulted in significant growth in the manufacturing of smart products and devices. In 2023, China's sales of smart onboard devices, drones, and 3D printers grew by 60.0%, 20.5%, and 36.2%, respectively. Smart instruments and apparatuses have accelerated digitization and intelligence in a variety of industries. The value added in the manufacturing of counter instruments for transportation equipment and industrial processes, as well as dedicated instruments for geological survey and seismic analysis, increased by 12.9% and 27.6%, respectively (Tang, 2024).

Among smart products, industrial and service robots stand out. As the world's largest robotics market, China has extensively deployed industrial robots in a wide range of industries, including autos, electronics, logistics, chemical engineering, and mechanical manufacturing. Industrial robots are most commonly used in emerging sectors like new energy vehicles, lithium batteries, and photovoltaics. Service robots are now being used in a variety of industries, including catering, medical, health, senior care, domestic services, and security. Dedicated robots are becoming more important in agriculture and forestry, emergency response, environmental protection, and scientific surveying. China has sustained significant growth in industrial robot sales since surpassing Japan to have the world's largest inventory of robots for the first time in 2016. In 2022, China's robotics sector generated approximately 170 billion yuan in revenue. By 2022, China had 1.357 million industrial robots, accounting for 52.5% of the global market share, with an annual composite growth rate of 28.8% during the decade, up from 14% in 2012. China manufactured 429,500 sets of industrial robots in 2023, exceeding 400,000 sets for the second year in a row, as well as 7.963 million service robots, a 23.3% increase over the previous year. China's overall imports and exports of industrial robots totaled 2.61 billion US dollars in 2022, and 2.66 billion US dollars in the first ten months of 2023, a 23% increase year on year¹.

4. New Stage for the Sophistication of Industrial Structure

4.1 China's Economy Has Shifted to A Service-Based Development Stage

Economic growth has catalyzed industrial upgrading. For the first time in 2012, China's value-added in the service sector as a share of GDP surpassed that of the secondary industry. As a historic transition, the tertiary industry has supplanted the secondary industry as the top driver of China's economic growth, with an increasing share thereafter. In 2015, China's service sector accounted for 50.8% of GDP, exceeding 50% for the first time. In 2023, the service sector's value-added accounted for 54.6% of China's economy and contributed 60.2% of its GDP growth. With a more stable "tertiary-secondary-primary" industrial structure, China's economy has evolved into a service-based modern economy (see Figure 3).

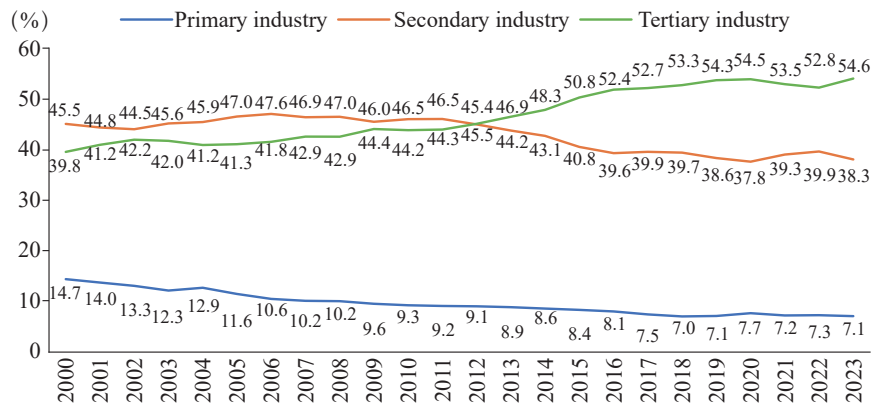


Figure 3: Changes in the Structure of China's Primary, Secondary and Tertiary Industries

Source: Compiled from the *China Statistical Yearbook* (2023) and the *Statistical Communiqué of the People's Republic of China on the 2023 National Economic and Social Development*.

¹ Source: (i) Sales and number of installed robots: *World Robotics 2023 Report* by the International Federation of Robotics (IFR); (ii) Output of industrial robots is based on *Key Manufacturing Data of Large Industrial Enterprises from January to December*. The growth in service robot manufacturing output is calculated using data from 2022.

4.2 Continued Improvement in the Service Sector's Internal Structure through Structural Adjustment

Producer services now account for more of China's industrial value-added than life services, and technology- and knowledge-intensive services have expanded considerably. In 2022, China's producer services had a value-added of 36.4503 trillion yuan, accounting for 57.3% of the service industry (see Figure 4). In 2023, finance, information transmission, software and IT services, leasing, and commercial services made up 27.8%, 13.8%, and 11.3%, respectively. Modern services and knowledge-intensive services are rapidly emerging as new cornerstones of China's service sector.

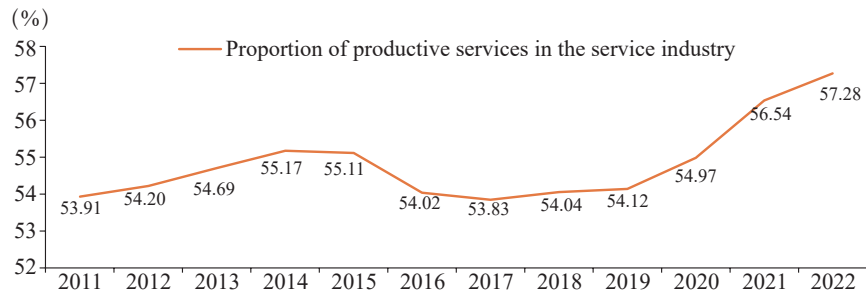


Figure 4: Changes in the Proportion of Productive Services in the Service Industry from 2011 to 2022

Source: Author's calculation.

4.3 High-Tech Sectors Became the Key Drivers of China's Industrial Development

Between 2018 and 2023, investments in China's high-tech sectors grew at an annual average rate of more than 10%, far above national fixed-asset investment growth rates. Massive expenditures have aided the transformation and upgrade of high-tech industries. In 2023, investments in China's high-tech industries rose by 10.3%, above the national average fixed asset investment growth rate by 7.3 percentage points. Investments in high-tech manufacturing and services climbed by 9.9% and 11.4% year on year, respectively, surpassing overall fixed-asset investment growth by 6.9 and 8.4 percentage points. In the high-tech manufacturing industry, investments in electronics and communications equipment manufacturing, computer and office equipment manufacturing, and aviation, aircraft, and equipment manufacturing rose by 11.1%, 14.5%, and 18.4%, respectively; in high-tech services, investments in e-commerce services and R&D commercialization grew by 29.2% and 31.8%, respectively (Zhai, 2024).

4.4 Industrial Integration Emerged as a Prominent Trend

With the integration of digital and real economies as a new normal, and the integration across advanced manufacturing and modern services and agriculture has entered in a new stage of development. According to the *World Service-based Manufacturing Index Report*, China's service-based manufacturing index for 2021 is 113.71, ranking fourth in the world and demonstrating consistent growth for five years in a row. According to Table 1, by 2023, the Ministry of Industry and Information Technology (MIIT) had issued a list of service-based demonstration manufacturing enterprises in five waves, which includes 372 demonstration enterprises, 225 platforms, and 157 projects. China's manufacturing industry is increasingly service-oriented. In 2022, the tertiary industry accounted for 25.7% of the value-added in agricultural and related sectors. Distribution services for agriculture, forestry, livestock breeding, and fishery, as well as related products, accounted for 14.1%. With the help of modern services, smallholders can now take part in modern agriculture, and such services are crucial to the growth and success of modern agriculture.

Table 1: Numbers of Service-oriented Manufacturing Demonstration Enterprise, Platforms, and Projects from the First to Fifth Batches

	First batch	Second batch	Third batch	Fourth batch	Fifth batch
Demonstration enterprises	30	33	88	111	110
Demonstration platforms	30	31	56	57	51
Demonstration projects	60	50	25	22	/

Source: Compiled by the author based on the list published on the official website of the Ministry of Industry and Information Technology.

4.5 Integration between Digital and Real Economy

In recent years, significant progress has been achieved in integrating the digital and real economies, as seen by the emergence of the new economy, which is driven by new industries, business models, and paradigms. From 2015 to 2022, China's new economy maintained an annual average value-added growth rate of 10.9%, which was 2.5 percentage points faster than GDP growth over the same time. In 2022, China's new economy had a value-added of 21.01 trillion yuan, accounting for 17.36% of GDP, up 2.6 percentage points from 2015 (see Figure 5). The new economy accounted for 4.0%, 44.2%, and 51.8% of China's primary, secondary, and tertiary industries, respectively. The new economy encompasses modern agriculture, forestry, livestock and fishery, advanced manufacturing, Internet and IT services, innovation and entrepreneurial services, and modern producer services, all of which contribute greatly to China's high-quality economic development and industrial upgrading. Notably, new business models in culture, tourism, and ecological services swept the country by storm in 2023. In 2023, the 16 sectors of the culture industry with distinguishing characteristics of the new business models generated a business revenue of 5,239.5 billion yuan, up 15.3% from the year before. New business models accounted for 70.9% of the business revenue growth of large culture businesses. "Zibo BBQ", winter sports, and ice-snow tourism went viral on social media. New business models for culture, sports, and ecological services have unleashed great potential for domestic economic circulation.

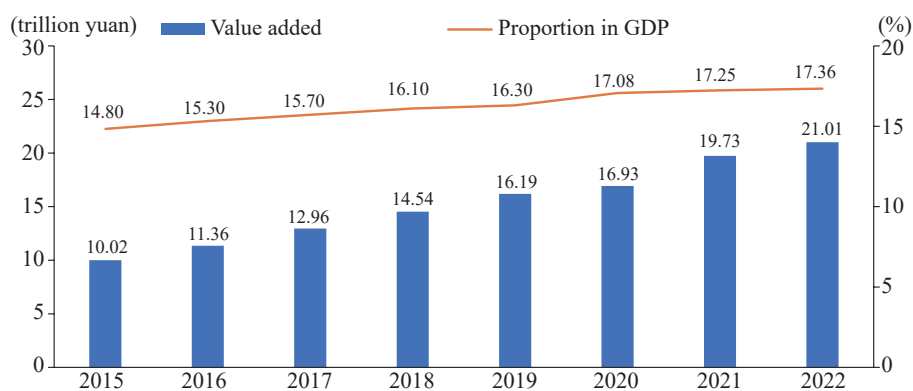


Figure 5: Value-added of the "Three New" Economy and Its Proportion in GDP from 2015 to 2022

Source: National Bureau of Statistics.

5. Digital Economy Fosters New Dynamism

5.1 Fast Growth in the Digital Economy Scale and Penetration Rate

According to the China Academy of Information and Communications Technology (CAICT),

China's digital economy grew by 10.3% year on year to 50.2 trillion yuan, accounting for 41.5% of China's GDP, equal to the share of the secondary sector. Globally, China's digital economy ranks among the top in terms of both value and share (see Figure 6). China's industrial digital economy has a penetration rate of 24%, and industrial enterprises have significantly boosted their use of CNC-controlled essential operations and digital R&D design tools. The digital economy's penetration rate in the service sectors was 44.7%. Agricultural digitalization spread throughout industrial chains, with a 10.5% penetration rate in the agricultural digital economy.

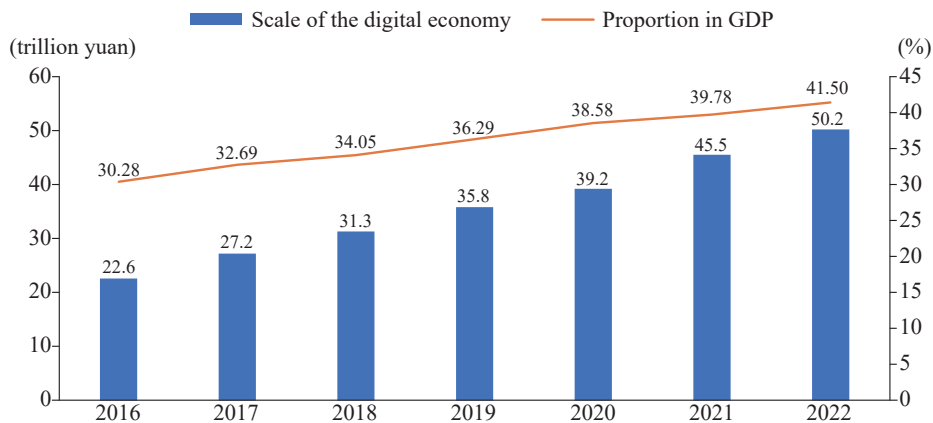


Figure 6: Development of China's Digital Economy

Source: Compiled from the annual reports published by the China Academy of Information and Communications Technology.

5.2 Data Factors Empowering Various Sectors

Today's world is in the midst of a fresh wave of technological and industrial revolutions. Data, as a new production factor, has entered the production function and is becoming ever more important for industrial development. It is a key factor for fostering new quality productive forces. In 2022, China contributed 10.5% of the world's total data generation, ranking second in the world, while its data storage accounted for 14.4% of the world's total. China's big data industry generated 1.57 trillion yuan in output value. Data collection, labeling, analysis, and storage have transformed data into a valuable resource. The data labeling sector has formed three industrial clusters in Beijing, the Yangtze River Delta, and the Chengdu-Chongqing region, resulting in technology spillover effects in neighboring regions. According to the "Data Factor×" *Three-Year Action Plan (2024-2026)*, China aims to implement the "data factor×" across 12 sectors, including industrial manufacturing, modern agriculture, trade circulation, and transportation. Based on the nation's extensive data resources, diverse application scenarios, and vast market size, this initiative seeks to enhance total factor productivity (TFP) by integrating data with labor and capital factors and utilizing data flow to guide technology, talent, capital, and material flows. By transcending the limitations of traditional factors, the Plan is designed to promote the multi-scenario application and multi-entity reusability of data. This will involve developing new products and services based on the data factor and exploring fresh avenues for economic growth. Furthermore, the Plan aims to expand the scale of data and diversify data categories to facilitate innovation and upgrade production tools, thereby fostering new industries and business models while injecting new dynamism into economic development (National Data Administration, et al., 2024).

5.3 Industrial Transformation and Upgrading Catalyzed by “AI+”

The concept of “AI+” first mentioned in *the 2024 Government Work Report* suggests extensive AI applications across sectors. It aims to integrate technical and industrial innovations to create new products, services, and business models. “AI+” is poised to transform traditional industries and socio-economic structures, shaping new dynamics and strengths for high-quality development. China has over 4,400 AI-related companies with around 10,000 digital workshops and smart factories, representing a core AI industry worth 500 billion yuan. According to the CCID Academy for Industry and Information Technology at the Ministry of Industry and Information Technology (MIIT), 15% of Chinese enterprises have adopted generative AI in 2023. The manufacturing, retail, telecom, and healthcare industries have experienced a surge in the adoption of generative AI, which has a market of 14.4 trillion yuan. By 2035, generative AI is expected to contribute 90 trillion yuan to the global economy, with China’s contribution to exceed 30 trillion yuan (Du, 2024).

5.4 Intelligent Manufacturing Made Headway in Industrial Sector

Rapid advancements in intelligent manufacturing have fueled automation-related industries. In 2023, the value-added in China’s manufacturing of electrical and electromagnetic components rose by 29.8% and 10.3%, respectively. Intelligent manufacturing applications have become more widespread and productive. Over 40% of Chinese manufacturing firms have adopted digital and network-based manufacturing processes, propelling China to the fifth place in the world in terms of industrial robot density. In the first half of 2022, China sold 131,000 manufacturing robots for 3 trillion yuan, meeting more than half of the market demand. China had built 62 “lighthouse factories” by the end of 2023, or 40% of the world’s total, as well as 421 national demonstration factories of intelligent manufacturing and over 10,000 provincial digital and smart factories (Wang, 2024).

5.5 New Service Business Models Such as E-Commerce and Online Marketing

China’s e-commerce market has steadily expanded over the years. In 2023, China’s e-commerce transaction volume was 46.83 trillion yuan, increasing 9.4% from the previous year (NBS, 2024). According to Ministry of Commerce data, China’s online retail sales volume in 2023 totaled 15.43 trillion yuan, up 11.0% from the previous year, making it the world’s largest online retail sales market for the 11th consecutive year². In 2023, China’s online sales of physical products climbed to 27.6% of total social consumer goods retail volume, reaching a new record. Continuous progress has been achieved in the integration of the real and digital economies, as well as the online and brick-and-mortar sales channels. New business modes, such as online platforms and e-commerce, are emerging as key drivers of industrial upgrading and economic vibrancy. In 2023, the online sales volumes of tourism, culture and entertainment, and catering increased by 237.5%, 102.2%, and 29.1%, respectively, contributing 23.5% to online retail sales volume and boosting online retail sales by 2.6 percentage points (Information Office of the Ministry of Commerce, 2024). In 2023, China’s courier service exceeded 130 billion parcels, with a monthly average of over 10 billion parcels, a 19.5% increase from the previous year.

² The e-commerce transaction volume refers to the transaction amount of goods and services conducted through e-commerce transaction platforms (including both proprietary platforms of companies and third-party platforms), encompassing transactions with both entities and individuals. Online retail sales refer to the retail transaction amount of goods and services conducted through public network trading platforms (mainly platforms dealing in tangible goods, including proprietary websites and third-party platforms). The growth rates of both e-commerce transaction volume and online retail sales are calculated on a comparable basis.

6. New Miracles in Green Economic Development

The Report to the 20th National Congress of the Communist Party of China (CPC) states, “Chinese modernization is the modernization in which man and nature coexist in harmony”. Green development, with equal emphasis on environmental benefits and economic efficiency, is a defining feature of Chinese modernization. In 2020, the Chinese government made a solemn pledge to “peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060”. This commitment reflects the determination to pursue a path of green, low-carbon, and high-quality development, aiming to achieve the highest reduction in carbon intensity globally and promote the global green development process. In recent years, China has established the concept that “green mountains are gold mountains” and has made consistent efforts to reduce carbon emissions and pollution while expanding greenery and economic growth. The green and low-carbon shift has benefited both “gold mountains” and “green mountains”.

6.1 Promoting Green Industrial Transition through Technological Innovation

By the end of 2021, China had filed 60,000 valid innovation patents for the new energy industry and 49,000 valid innovation patents for energy conservation and environmental protection, representing 1.7 and 1.6 times the levels at the end of 2017. Between 2011 and 2020, China filed over 60% of environmental technology innovation patents in the world, making it the most proactive country for environmental technology innovations (Information Office of the State Council of China, 2023). In recent years, China has seen a steady increase in its energy and resource efficiency, as well as continuous advances in the green manufacturing system. Green industrial development has been accelerated by technological progress in new energy, pollution reduction, and environmental monitoring that have reached internationally advanced levels.

6.2 Leading in New Energy Products

In 2023, new energy products began to spearhead China’s green development, transforming into a new driver of economic growth. In 2023, China’s manufacturing output of electric vehicles (EVs), lithium batteries, and solar panels increased sharply from the previous year. China’s manufacturing output of wind turbines, hydropower turbines, and charging facilities increased by 28.7%, 35.3%, and 36.9% from 2022, respectively, while the manufacturing output of ultra-clear glass for solar panels, carbon fiber composite materials, and bio-based chemical fibers increased by 58.6%, 57.1%, and 50.7%, respectively (Tang, 2024). In 2023, China’s manufacturing output of polycrystalline silicon, silicon wafers, batteries, and components accounted for more than 70% of the global total (China Youth Network, 2024).

6.3 Thriving Renewable Energy Industry

According to the National Energy Administration (NEA), China’s newly installed renewable energy capacity reached 152 million kW in 2022, accounting for 76.2% of the country’s newly installed power generation capacity. The newly installed capacity of wind power, solar power, biomass power, conventional hydropower, and pumped storage hydropower (PSH) grew by 37.63 million kW, 87.41 million kW, 3.34 million kW, 15.07 million kW, and 8.8 million kW respectively. By the end of 2022, China’s installed renewable energy capacity surpassed 1.2 billion kW, totaling 1.213 billion kW and accounting for 47.3% of its total installed generation capacity. Specifically, China’s wind, solar, biomass, conventional hydropower, and PSH power had reached installed capacities of 365 million kW, 393 million kW, 41 million kW, 368 million kW, and 45 million kW, respectively (NDRG Department of Resource Conservation and Environmental Protection, 2023). In 2023, China’s installed

renewable energy capacity expanded to 1.45 billion kW, accounting for more than half of the country's total installed power generation capacity for the first time ever. China leads the world in wind, solar, hydropower, and biomass power installed capacities, becoming a major supplier of wind and photovoltaic equipment and power batteries while also reducing renewable energy deployment costs globally. Many parts of China had integrated smart zero-carbon power plants completed by 2023; such decentralized zero-carbon power plants, which prioritize green electricity from wind, solar, and hydropower while burning no coal, congregate scattered sources of power generated from factories, shopping malls, and households to feed zero-carbon electric power to the power grid via smart modulation (Bai, 2024).

6.4 Green Modern Industrial System Initially Took Shape

Green technology is rapidly replacing resource-intensive and polluting processes in traditional sectors. Great efforts have been made to cultivate emerging green industries, inspire dynamism for green development, integrate emerging technologies such as AI and big data into green industries, and promote green industry with new quality productive forces. Green factories, green industrial chains, and green industrial parks have been built to establish complete green product supply chains, from raw materials to finished products.

7. New Strides in Industrial Internationalization

In recent years, China has opened up at a higher level, established an open new economic system, and embraced the Belt and Road Initiative (BRI), providing opportunities for other nations with its own development. China's overall imports and exports of goods in 2022 reached 6.31 trillion US dollars, more than 13 times the amount in 2000. China has endeavored to enhance BRI economic and trade cooperation, increasing its imports and exports with BRI countries to 46.6% of its total trade volume in 2023. With new platforms for opening up under construction, the share of China's imports and exports through free trade experiment zones has risen to 18.4% (Sheng, 2024).

7.1 High-Tech Exports Became China's Primary Export Products

With an increasing international competitiveness, China has completed the transition from processing trade and labor-intensive exports to general trade, electromechanical, and high-tech exports. As shown in Table 2, in 2023, China exported 13.92 trillion yuan worth of electromechanical products, accounting for 58.6% of its total exports, outshining its labor-intensive exports worth 4.11 trillion yuan, or 17.3%. Electric vehicles (EVs), lithium batteries, and solar panels have become the "new big three" of China's foreign trade. According to the General Administration of Customs, China's "new big three" exports surpassed 1 trillion yuan for the first time in 2023, reaching 1.06 trillion yuan, up 29.9%, indicating a considerable growth in its international market share.

Table 2: China's Product Export Trade from 2012 to 2023

	Goods exports Total amount (100million yuan)	Including: General trade (100million yuan)	%	Processing trade (100million yuan)	%	Electromechanical products (100million yuan)	%	High-Tech products (100million yuan)	%
2012	129337	62368	0.48	54464	0.42	74450	0.58	37951	0.29
2013	136845	67351	0.49	53292	0.39	78356	0.57	40894	0.30
2014	143912	73944	0.51	54320	0.38	80527	0.56	40570	0.28
2015	141255	75456	0.53	49553	0.35	81421	0.58	40737	0.29

Table 2 Continued

	Goods exports Total amount (100million yuan)	Including: General trade (100million yuan)	%	Processing trade (100million yuan)	%	Electromechanical products (100million yuan)	%	High-Tech products (100million yuan)	%
2016	138455	74601	0.54	47237	0.34	79820	0.58	39876	0.29
2017	153321	83325	0.54	51381	0.34	89465	0.58	45150	0.29
2018	164177	92405	0.56	52676	0.32	96457	0.59	49374	0.30
2019	172342	99546	0.58	50729	0.29	100631	0.58	50427	0.29
2020	179326	106460	0.59	48589	0.27	106608	0.59	53692	0.30
2021	217348	132445	0.61	53378	0.25	128286	0.59	63266	0.29
2022	239654	152468	0.64	53952	0.23	136973	0.57	63391	0.26
2023	237726	153530	0.65	49062	0.21	139196	0.59	59279	0.25

Source: Compiled based on *Statistical Communiqué of the People's Republic of China on National Economic and Social Development* from 2012 to 2022.

7.2 China's ODIs Rank among the Highest in the World

In 2022, China's ODIs totaled 163.12 billion US dollars, placing it second in the world and among the top three for 11 years in a row, and accounting for more than 10% of worldwide ODIs for seven years (see Figure 7). China's ODI inventory reached 2.75 trillion US dollars by the end of 2022, placing it among the top three in the world for the sixth consecutive year (Ministry of Commerce of the People's Republic of China et al., 2023). Between 2013 and 2021, China made ODIs in the BRI countries totaling 161.3 billion US dollars, with an annual average growth rate of 5.4%. BRI countries have emerged as preferred investment destinations for Chinese firms. Twenty years ago, traditional industries like mining and manufacturing dominated China's ODIs. Today, the tertiary industry serves as the backbone. China's ODIs in the information industry and scientific research and technical services have grown at 32% and 20% during the past ten years, respectively. In 2022, China made ODIs in 18 industrial sectors totaling more than 10 billion US dollars, including mining, manufacturing, transportation, finance, retail and wholesale, leasing, and commercial services. In 2020, overseas Chinese-funded firms paid 44.5 billion US dollars in taxes to their host countries and regions. In the same year, 2.188 million foreign workers were engaged by overseas Chinese-funded firms (Wang, 2021). Chinese firms have made vital contributions to global win-win cooperation, common progress, and prosperity.

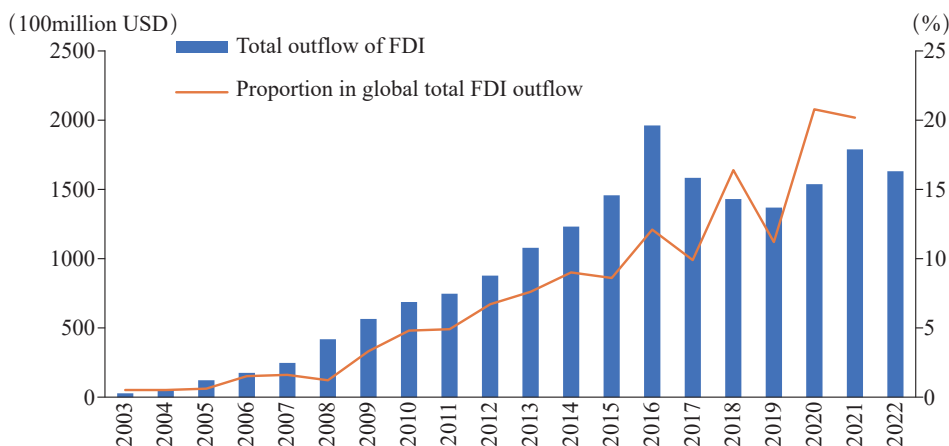


Figure 7: China's FDI from 2003 to 2022

Source: National Bureau of Statistics.

7.3 Industrial Internationalization Refocused from “Going Global” to “Integrating Locally”

Chinese companies have gone through three stages of internationalization, which include the internationalization of products, capital, and capabilities. Among them, the internationalization of capabilities implies that Chinese firms must be able to operate in foreign markets in a localized manner. Over the past few decades, Chinese businesses have progressed from product export to the internationalization of products, capital, business model, marketing strategy, and technologies. Previously, Chinese companies focused on exporting goods, lacked coordination when investing abroad, and acquired foreign businesses hastily. Nowadays, they have turned their focus to exporting business concepts, formed industry coalitions, and begun to integrate with acquired businesses. These changes reflect a general trend that Chinese firms are heavily involved in, and even transforming, global value chains in order to develop localized operations in those markets. For example, about 90% of Chinese companies on the *Fortune China 500* list have conducted various forms of international commerce in 2021, and roughly half of those businesses continue to prioritize overseas business growth as a strategic priority. While only 10% of them prioritize overseas mergers and acquisitions, the vast majority of those Chinese companies have attached importance to localized overseas operations: 29% of them prioritize overseas marketing capabilities, 24% of them prioritize overseas supply chains, and 11% of them prioritize overseas technology (LinkedIn China, Boston Consulting, 2022). ■

References:

- Bai X. Progress in China’s Green Transformation from the Perspective of 2023 “Dual Carbon” Work [EB/OL] (2024-01-16) [2024-03-05]. https://www.ndrc.gov.cn/wsdwhfz/202401/t20240116_1363300.html.
- Chen B. China’s Economic Powerhouse Advances Steadily [J]. *Economy*, 2024(01): 51-53.
- China Youth Network. In 2023, China’s New Energy Vehicle Exports Reached 1,203,300 Units, a Year-on-Year Increase of 77.2%, Setting a New Historic High [EB/OL] (2024-01-18) [2024-03-05]. https://news.youth.cn/gn/202401/t20240118_15030545.htm.
- Department of Environment and Resources, National Development and Reform Commission. 2022 China Renewable Energy Development Situation [EB/OL] (2023-02-15) [2024-03-02]. https://www.ndrc.gov.cn/fggz/hjzyzj/jnhnx/202302/t20230215_1348799_ext.html?eqid=b938b34c000a108700000006645da045
- Du Z. Viewing the Strategic Emerging Industries of 2023 from New Changes in the Industry [EB/OL] (2024-01-16) [2024-03-05]. https://www.ndrc.gov.cn/wsdwhfz/202401/t20240116_1363298.html.
- Fan S. L. Accelerating Innovation-Driven Development with High-Intensity, High-Level, and Efficient Research Investment[N]. *China Economic Times*, 2023-09-20.<https://baijiahao.baidu.com/s?id=1777514388229413868&wfr=spider&for=pc>.
- Huang H. Exports of the “New Big Three” Surpass One Trillion Yuan for the First Time [EB/OL] (2024-01-12) [2024-03-05]. <https://baijiahao.baidu.com/s?id=1787869650825655675&wfr=spider&for=pc>.
- LinkedIn China, Boston Consulting Group. White Paper on the International Development of Chinese Enterprises[R]. <https://business.linkedin.com/content/dam/me/about/china/whitepaperongoinglobal.pdf>.
- Ministry of Commerce, National Bureau of Statistics, State Administration of Foreign Exchange of the People’s Republic of China. 2022 Annual Report on China’s Foreign Direct Investment Statistics[M]. Beijing: China Commerce and Trade Press, 2023.
- National Bureau of Statistics. China Innovation Index Increased by 5.9% over the Previous Year in 2022 [EB/OL] (2023-10-20) [2024-03-01]. https://www.stats.gov.cn/sj/zxfb/202310/t20231020_1943765.html.
- National Bureau of Statistics. Results of China Innovation Index Measurement Indicate: Continuous Improvement

in China's Innovation Development Level [EB/OL] (2023-10-20) [2024-03-02]. https://www.stats.gov.cn/sj/sjjd/202310/t20231019_1943766.html.

National Bureau of Statistics. Statistical Communiqué on the National Economic and Social Development of the People's Republic of China for the Year 2023 [EB/OL] (2024-02-29) [2024-03-20]. https://www.gov.cn/lianbo/bumen/202402/content_6934935.htm.

National Data Bureau, etc. Notice on the Issuance of the “Data Element ×” Three-Year Action Plan (2024-2026) [EB/OL] (2024-01-05) [2024-02-24]. https://www.cac.gov.cn/2024-01/05/c_1706119078060945.htm.

Press Office, Ministry of Commerce. Representative of the E-commerce Department of the Ministry of Commerce Discusses China's E-commerce Development in 2023 [EB/OL] (2024-01-19) [2024-03-03]. <http://www.mofcom.gov.cn/article/xwfb/xwsjfzr/202401/20240103467547.shtml>.

Sheng L. Y. Overcoming Difficulties, Recovering, and Moving Towards New Objectives – A Review of the “2023 National Economic and Social Development Statistical Communiqué” [EB/OL] (2024-02-29) [2024-03-07]. https://www.stats.gov.cn/sj/sjjd/202402/t20240229_1947920.html.

Tang W. W. Solid Progress in High-Quality Industrial Development and Growth of New Drivers [EB/OL] (2024-01-18) [2024-03-02]. http://www.ce.cn/xwzx/gnsz/gdxw/202401/18/t20240118_38870840.shtml.

The State Council Information Office of the People's Republic of China. China's Green Development in the New Era [R] (2023-01-19) [2024-03-10]. http://www.scio.gov.cn/zfbps/ndhf/49551/202303/t20230320_707652.html.

Wang S. S. Digital China Accelerates the Building of the Digital Economy, Continuously Empowering High-Quality Development [EB/OL] (2024-04-05) [2024-04-06]. <https://baijiahao.baidu.com/s?id=1795455477748388771&wfr=spider&for=pc>.

Wang W. Z. Quality and Quantity of China's Foreign Investment Rise Simultaneously[N]. People's Daily Overseas Edition, October 26, 2021. <https://news.cctv.com/2021/10/26/ARTIKAGVifq5dZ12CCdzfKgg211026.shtml>.

Xinhua News Agency. Data Reading of China This Decade | Ten Sets of Data Witness the Great Achievements of the New Era [EB/OL] (2023-12-12) [2024-02-28]. <https://baijiahao.baidu.com/s?id=1785003512487486108&wfr=spider&for=pc>.

Zhai S. Q. Steady Growth in Fixed Asset Investment and Continuous Optimization of Investment Structure (2024-01-18) [2024-03-03]. http://www.ce.cn/xwzx/gnsz/gdxw/202401/18/t20240118_38870847.shtml.