Economics, Law and Policy
ISSN 2576-2060 (Print) ISSN 2576-2052 (Online)
Vol. 5, No. 2, 2022
www.scholink.org/ojs/index.php/elp

Original Paper

An Analysis of the Status of China's Digital Economy and Infrastructure

Li Chunzhi[1]

[1] College of Finance and Economics, Sichuan International Studies University, Chongqing, PR China

Received: November 10, 2022 Accepted: November 30, 2022 Online Published: December 13, 2022

doi:10.22158/elp.v5n2p69 URL: http://dx.doi.org/10.22158/elp.v5n2p69

Abstract

China's digital economy, ranking second worldwide for many years, has become a major growth engine for the economy and promotes high-quality economic development. The increase of the digital economy size is driven by the industrial digitization and benefits from the construction of digital infrastructure. China leads the world in 5G, supercomputing, and navigation satellite system while also has the fastest-growing market of cloud computing service in the world. In the future, China should focus more on application of digital technology in production process instead of consumption process, narrowing the digital gap in different regions, and attaching importance to both the construction of hardware infrastructure and the development of underlying infrastructure technologies.

Keyword

Digital Economy, Digital Infrastructure, Digital Technology

1. Introduction

Digitization is one of Chinese government's key targets in the government's 14th Five Year Plan (FYP) released in early 2021, planning the development road for the period from 2021 to 2025. A large number of literatures focused on digital economy. The first branch literature explored the outcomes of digital economy indicating that the development of digital economy will bring vitality and resilience to the economy and prevent a potential crunch that could stifle growth (Huo & Wang, 2022; Myovella et al., 2020; Ozturk & Ullah, 2022). Related literature revealed that the usage of digital factor in the economy activities has positive impact on economy, social life and environment by improving firm performance (Heredia et al., 2022), alleviating poverty (Lechman & Popowska, 2022), enrich social networks (Yin et al., 2019), altering urban development patterns (Zhu & Chen, 2022) and reducing carbon emissions (Cheng et al., 2023).

On the other hand, digital economy benefits a lot from the construction of the digital infrastructure. These are the second branch literatures. For example, broadband expansion and construction of big data center make economic factors digitization possible thus promote the growth of digital economy (Zhou, 2022; Kolko, 2012). The third branch of researches studies the phenomenon of digital divide and digital dividend. These studies discussed the reasons, the negative influence of digital divide and positive effects of digital dividend on several aspects of social economic activities (Liu et al., 2022; Reddick et al., 2020).

This study contributes to the literature in two ways. First, the study describes the status of Chinese digital economy by collecting facts from the aspects of size, speed, components and spatial distribution. Unlike the existing literature, the study aims to show the big picture of Chinese digital economy development systematically. Such research will improve the understanding of the digital economy in China and build foundation for empirical research investigating causal relationship.

Second, the study comprehensively investigates the digital infrastructure including hardware and software deviating from the existing researches focusing on a particular new digital infrastructure or technique. Based on the analysis of supercomputing, 5G, navigation satellite system, big data center and cloud computing, the study concludes the characteristics of the development of digital infrastructure and proposed policy recommendation.

2. Digital Economy in China

2.1 Evolution of Chinese Digital Economy

The concept of digital economy was first put forward by OECD in the 1990s. G20 referred to the digital economy as a series of economic activities with digital knowledge and information as key production factors, basing on modern information network and the Information and Communication Technology (ICT).

China has the world's second largest digital economy. In 2021, China's digital economy reached a size of about 45.5 trillion-yuan, accounting for 39.8 percent of its GDP (Note 1). The scale was only 2.6 trillion and accounting for 13.9 percent of GDP in 2005. Figure 1 illustrates the market size of digital economy in China in selected years from 2005 to 2021. During this period, both the scale of digital economy and its proportion in GDP has recorded higher every year indicating the steady trend of digital economy development in China.

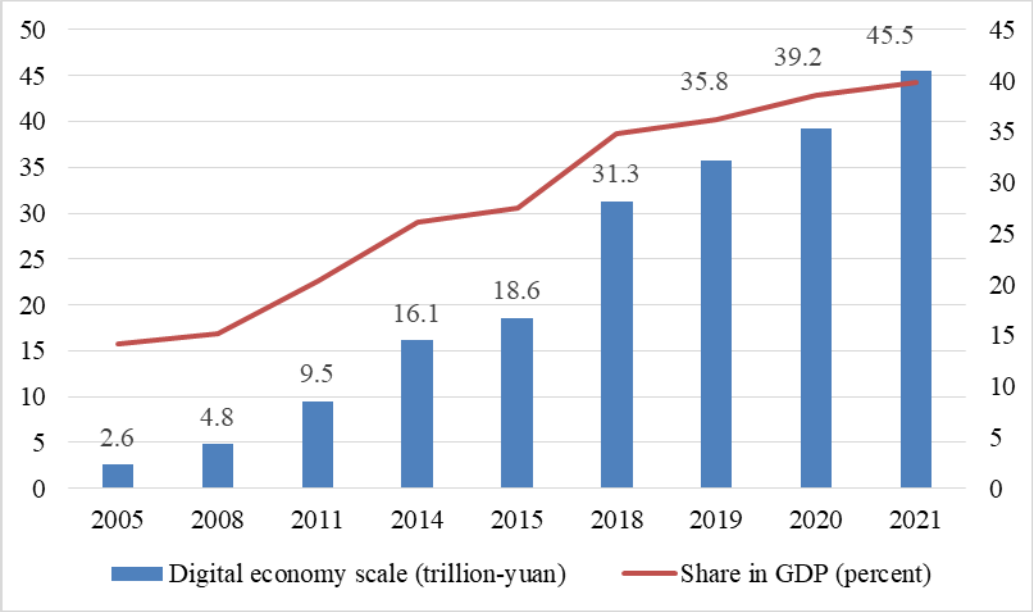

Figure 1. Market Size of the Digital Economy in China

Source: CAICT, http://www.caict.ac.cn/.

In 2019, the nominal growth rate of digital economy is 15.6 percent, much higher than the nominal GDP growth at 7.85 percent. In 2021, China's digital economy registering a nominal yearly growth rate of 16.2 percent, still higher than the nominal GDP growth at 3.4 percent.

The surge of the digital economy was mainly driven by the integration of ICT with traditional sectors (industrial digitization). Figure 2 shows that the size of industrial digitization rise from 24.9 trillion-yuan in 2018 to 37.2 trillion-yuan in 2021, contributing about 80 percent of total digital economy in the period of 2018 to 2021. The overall size of digital sectors (digital industrialization) remains rather small and stable at around 7 trillion-yuan.

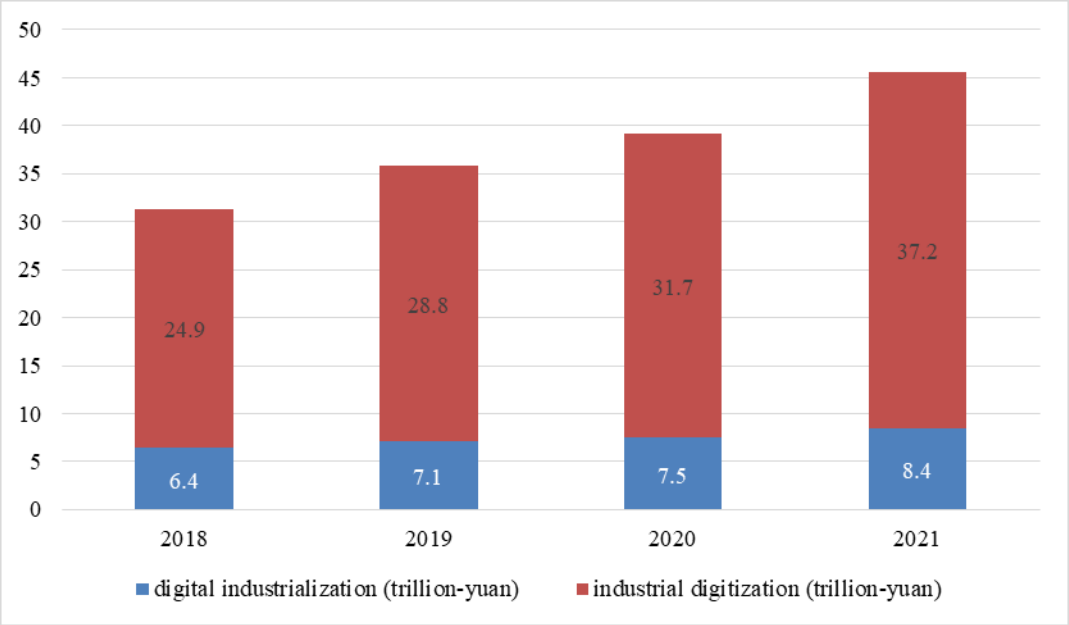

Figure 2. Industrial Digitization and Digital Industrialization

Source: CAICT, http://www.caict.ac.cn/.

The degree of digitization varies across three main industries. The service sector is the most digitalized, with ICT contributing 37.8 percent of the sector's value-added in 2019. The industrial sector is lagging, with ICT contributing 19.5 percent, and the agriculture sector is the least digitalized, with 8.2 (Note 2) percent in 2019. Among the service sectors, subsectors with the highest level of ICT are mostly in financial services. In the industrial sector, the advanced manufacturing sector is the most digitalized. According to the data in 2021, 55.7 percent of the key processes of industrial enterprises above designated size had become digitally controlled and the popularization rate of digital R&D tools reached 75.1 percent.

Thus, the rise of the size of digital economy was mainly driven by the industrial digitization rather than digital industrialization and more specifically, the business to consumer is more digitalized than the business related to producers. This indicating that improving the levels of digitization in terms of industrial sectors is crucial and promising.

2.2 The Digital Divide in China

The degree of digitization varies across the country. China's provincial digital economy has exhibited a spatial distribution pattern of "high in the eastern provinces/coastal regions and low in the western and central provinces". Prefectural cities with high digital development levels are mainly agglomerated in large metropolitan areas, such as Yangtze River Delta, the Jing-Jin-Ji, the Guangdong-Hong Kong-Macau Greater Bay Area. Prefectural cities with low digital development levels are concentrated in the rural-mountainous regions in southwest China and poverty-stricken areas in central and western China (Song et al., 2020). For example, Beijing, Shanghai have shown very strong digital growth and

the scale of digital economy in Beijing and Shanghai is close to 45 percent of its GDP while this is only 15 percent in Henan, a central province. This is the results of the diverse stages of economic development and technology in each region, more specifically, the urban-rural income gap and the inequality of education.

Another presentative phenomenon is the urban-rural digital divide. There are significant differences between urban students and rural students in accessing the digital education and inspiration (Li & Ranieri, 2013). Though the urban-rural digital divide at school is modest because regular use of computers in both rural and urban public schools, the digital divide was much wider in terms of advanced computer skills, using the internet and creative activities using computers. These gaps come from the experience off class and at home: urban students reported having greater access to the computer hardware, software and computer languages than their rural counterparts.

3. The Position of Chinese Digital Economy in the World

China's overall digitization stands in the middle of the range globally. In 2019, the digital economy in China account for about 35.8 percent of GDP, lower than that in the U.S (59 percent) and Japan (46 percent), but higher than that in Brazil and India (both around 20 percent). Using other indices shows the similar picture. China ranks 50th out of 131 countries based on the World Bank digital adoption index, 59th out of 139 countries in the World Economic Forum index (Zhang & Chen, 2019). The employment in the ICT sector composes 2.6 percent of total employment in China in 2010. This index in China is lower than the OECD average (3.7 percent) indicating that China is still below the OECD average level of development in the digital sectors in terms of employment share (Garc á-Herrero & Xu, 2018).

Several reasons behind the middle position of China's digital economy. First, China still has a large rural economy. Given that digitization is much higher in urban areas and service sectors and industrial sector, the country's digital share will rise as the process of urbanization and industrialization.

Second, the indices measure the total digital economy, hence mask the diversity across sectors and regions in China. In fact, the digital economy developments in China are uneven. Developed regions such as Beijing and Shanghai seeing similar or even higher proportion of digital economy than developed countries, but the least-developed Chinese regions lag quite far behind. As the spillover effect continue to work, underdeveloped regions can take advantages of its developed neighbors. On the other hand, the overall proportion also ignore the differences among sectors. In fact, China has become a global leader in some key digital industries such as e-commerce and mobile payments. According to the data in 2019, China accounts for over 40 percent of global transactions. The penetration of e-commerce, the sales of e-commerce in total retail sales stands at 15 percent, compared to 10 percent in the U.S.

Third, China's GDP is in the second position worldwide which results in a larger denominator as calculating proportion. Thus, the overall share of digital economy in GDP become lower.

4. Digital Infrastructure in China

The development of Chinese digital economy benefits from the construction of infrastructure in digital technology in China. This part introduces supercomputing, 5G, navigation satellite system and big data center respectively.

4.1 Supercomputing

China leads the world in supercomputing. According to the lates TOP500 list of supercomputers unveiled at the 2016 International Supercomputing Conference in Frankfurt, Germany, Chinese supercomputer has snagged the top spot. The new machine, known as the "Sunway TaihuLight", located in National Supercomputing Center in Wuxi, Jiangsu province. It has performance of 93 PFlop/s, nearly three times the performance of the second place, another Chinese supercomputer, named "Tianhe-2". And more important, for the first time, China has overtaken the United States with the largest aggregate supercomputing capacity.

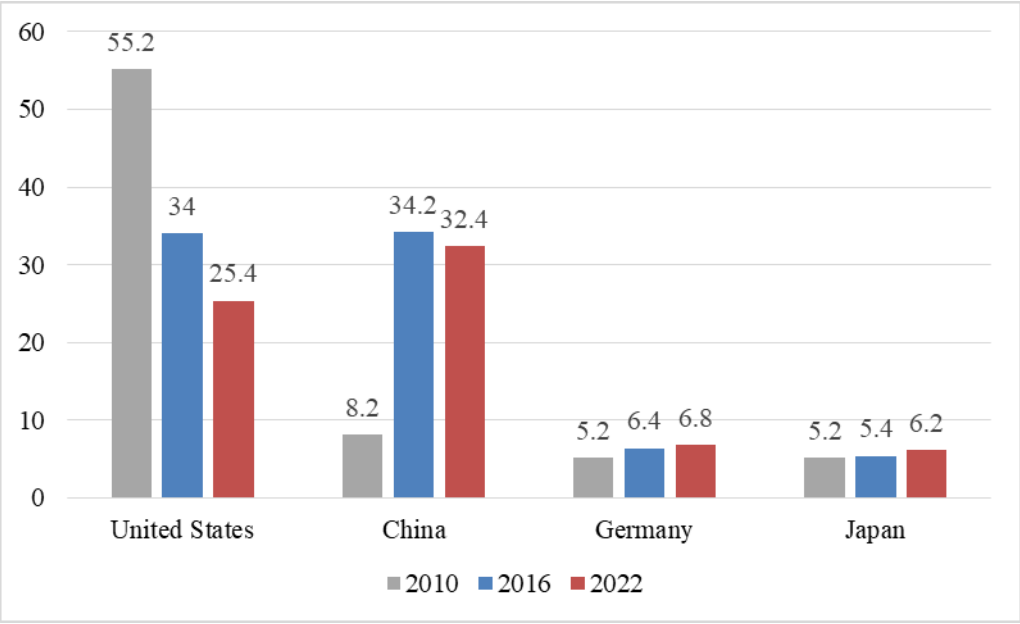

Figure 3. Supercomputing System Share (%)

Source: https://www.top500.org/.

China has 167 of the world's top 500 supercomputers, with a total capacity of 211 PFlop/s in 2022. The United States has 165 of the top machines, with a cumulative capacity of 173 PFlop/s. That's a reversal of the rankings 15 years ago, when the United States had more than half of the world's top 500 supercomputers. Europe's share, meanwhile, has dropped to 105 with a combined capacity of 115 PFlop/s. Figure 3 shows the supercomputing share by countries and years. Only the share of Chinese supercomputing surged quickly.

The newest list released in May 2022 shows that, the U.S supercomputer “Frontier” from DOE/SC/Oak Ridge National Laboratory has claim the crown with performance of 1102 PFlop/s. The Second place is Supercomputer Fugaku from Japan with performance of 442 PFlop/s. Among the top ten fastest supercomputers in the world, the United States holds five seats while China holds two, the sixth “Sunway TaihuLight” and the ninth “Tianhe-2”.Application of supercomputer has three levels. Advanced supercomputing services for aerospace, meteorological monitoring, etc. General supercomputing services for biopharmaceuticals, scientific research, etc. and business supercomputing services for financial economy and other industries. In 2022, China’s supercomputing service market reached 19.66 billion yuan.

4.2 5G

5G is the wireless standard that is a step beyond 4G. It has three characteristics: High speed, low latency, wide coverage. The average downlink rate of 5G is 500Mbps, or about 50MB/s, 10 times that of 4G. 5G network has the ultra-low delay of only 1-5 millisecond and support 1 million connections per square kilometer.

2019 saw the first year of commercial 5G. In the past three years, Mass 5G network deployments in China results that China dominates Global 5G base station count. China accounted for 60 percent of the total number of 5G base stations deployed globally by end-September 2022. Meanwhile, the total count of 5G base stations in China reached 2.22 million with a growth rate of 6.4 percent and a net increase of 795,000 5G base stations from the end of 2021.

The 5G subscribers reached 510 million in 2022, a net increase of 155 million over last year, accounting for 30.3 percent of mobile phone users and making it the largest user group in the world. Chinese operators target 560 million 5G subscribers by end-2023, which would comprise almost 35 percent of the world’s users.

In 2021, 5G coverage grew by a whopping 350 percent to cover 1336 cities in 62 countries. This resulted in that commercial 5G is available in 30 percent of the world’s countries. However, a year prior, only 378 cities had 5G coverage. In Asia, 528 cities are with 5G coverage. The count is 459 in Europe, Middle East, and Africa and 349 in America.

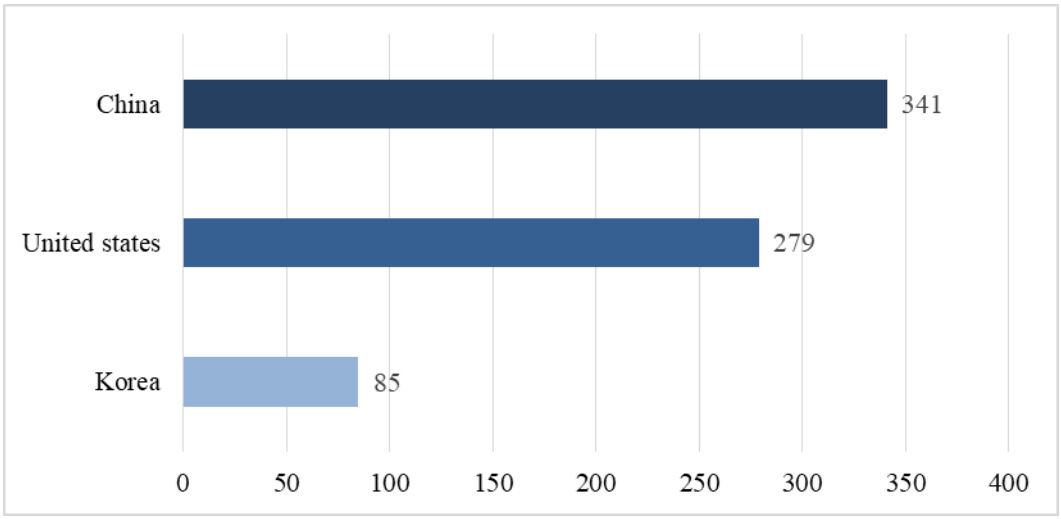

Figure 4. Top Countries with 5G Coverage by Number of Cities Covered

Source: VIAVI Solutions. The State of 5G: 5G Deployment Surge Despite Global Pandemic.

As for coverage in China, 5G covers all the urban areas (of prefecture cities and the county) and more than 92% town in the rural areas. China has the number of 341, the largest number of cities covered by 5G, followed by the U.S. with 279 cities and South Korea with 85 cities.

As for speed, South Korea had the fastest 5G in the world with median download speed of 492.5Mbps while Seoul reached 530.8Mbps. China ranked 8 with median download speed of 299Mbps according to the third quarter (Q3) data in 2021.

By June 2022, China hosted the world's largest 5G standards and technology, with 1.85 million 5G cell towers and 455 million 5G cell phone subscribers. Now, the internet penetration rate had reached 74.4% with 1.05 billion internet users in China which made China become one of the global leaders in 5G standards and technology.

4.3 Big Data Center

A major new infrastructure and development plan aims to expand the scope of China data centers to improve the country's data processing, storage, and computing capacity. The plan will see the construction of eight computing hubs and ten data centers across regions. This is aim to ultimately send data from China's populous and prosperous eastern regions to the resource-rich and sparsely populated western regions. Through this, China will be able to correct to imbalance in supply and demand of computing capacity, relieve the calculation pressure in eastern provinces, create clean energy data centers with lower cost and less environment burden.

In February 2022, China approved to construction first four regional computing hubs: the Yangtze River Delta hub, the Jing-Jin-Ji hub, the Guangdong-Hong Kong-Macau Greater Bay Area hub and the Chengdu-Chongqing hub. Another four regional hubs of Guizhou, Inner Mongolia, Gansu, and Ningxia are prepared to guaranteeing computing power for the future. Despite these eight computing hubs in key areas in western and eastern China, the Chinese government also planned to construct 10 data

center clusters within these hubs. These 10 data center clusters will contain several data centers adapted to the purposes of the region.

4.4 Global Navigation Satellite System

With the BeiDou-3 global navigation satellite system now operational, and beginning to provide global services in July 2020. Thus, China had developed the third mature satellite navigation system after GPS and GLONASS by deploying 45 satellites in 27 years. As an essential space infrastructure, BeiDou-3 served transportation, public security, emergency management, agriculture, forestry and other industries, integrated into power, finance, communications and other infrastructure, and widely entered the fields of public consumption and people's livelihood. Related industrial scale has exceeded 469 billion yuan in 2021.

China is speeding up shifting from traditional infrastructure construction to new digital infrastructure development in an effort to promote economic transformation and stimulate economy amid the ongoing global recession during coronavirus period. 5G base station, global navigation satellite system, supercomputers and big data centers are all important digital infrastructures that will affect the digital economy. Massive spending in such high-tech sectors will generate new business opportunities, expand size of the consumer market, upgrade consumption on both online and offline channels. On the other hand, it will promote production efficiency and innovation of product and service patterns.

Unlike traditional infrastructure such as railways and highways, new digital infrastructure includes information infrastructure and systems based on networks and computing power. China now vigorously cultivates new technologies and applications such as cloud computing to accelerate the transformation from industrialization to digitization.

4.5 Cloud Computing

Cloud computing is an important basic technology to realize the transformation and upgrading of financial institutions and enterprises. China's cloud computing market is the fastest-growing in the world. It is predicted that the global share of the Chinese public cloud service market will increase from 6.5 percent in 2020 to 10.5 percent in 2024. In 2020, the market size for public cloud services in China already reached US$19.38 billion, growing at 49.7 percent year on year.

Cloud computing emerged as a critical pillar of the digital economy. The growth of digital economic output in the world's top 35 economies were proved to be highly associated with their public cloud market. According to recent data, Chinese cloud infrastructure services expenditure grew 21 percent year on year to reach US$7.3 billion in Q1 2022, 13 percent of global cloud infrastructure spend. The top four leaders of the cloud service vendors Alibaba Cloud, Huawei Cloud, Tencent Cloud and Baidu AI Cloud, accounted for 79% of total expenditure in China.

Cloud computing is the on-demand delivery of computing resources, such as networks, servers, and storage, to a sizable number of end-users. Cloud computing is a combination of a series of technologies. Distributed computing, the key technology of cloud computing is to decompose a large and complex task into multiple small tasks and allocate them to different computing resources for processing.

For public, cloud computing services are available in three ways including infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS), software-as-a-service (SaaS). IaaS suppliers provide customers access to computing resources, such as network, storage and CPU with 24 hour's technique support. PaaS vendors provide a platform for software development and hosting, enabling customers to design application based on their own needs. SaaS providers offer online software that customers can access via a web browser. PaaS and SaaS suppliers also provide professional technical service in the development, debugging, optimization, upgrading and use of software.

5. Conclusion

The Chinese government has made the development of the digital economy to a national strategy, formulated development plans and vigorously developed the digital economy. A comprehensive understanding of China's digital economy development is the basis for all researches.

The patterns of Chinese digital economy can be summarized. The market size of China's digital economy ranked second worldwide behind the United States and has been growing rapidly in recent years. The total increase in digital economy was mainly due to the increase in the digitalized industrial sectors. In addition, there is digital gap among regions and industries.

The characteristics of digital infrastructure can be concluded. First, the application scenarios begin to go beyond the needs of consumers to meeting the needs of producers. Infrastructures such as 5G, supercomputing, new data hubs are all critical physical infrastructure for industrial production. With the advent of internet of Things (IoT) and industrial Internet of Things (IIoT), the industries and business's demand for computing power will be far greater than that of consumers. Second, hardware and software has developed together to build a complete technical system. China has great advantages in the construction of hardware infrastructure. Now China has made breakthroughs in software technology. China's cloud computing has developed rapidly and can respond to the needs of domestic enterprises. Third, network and computing are the primary factors in digital economy. Now China lead in both the network infrastructure and computing infrastructure to satisfy the transmission and computing needs.

The rapid development of the Information and Communication Technology (ICT) sector has brought significant economic and social benefits. In the future, whoever grasps the new digital infrastructure can succeed in digital economy development. Digital infrastructure should be planned as a whole to correct an imbalance between the computing supply and demand. The plan "Eastern Data, Western Computing" is helpful to narrow the digital divide and improve computing efficiency. The government should also encourage the adoption and application of digital technology in industrial production while still take advantages of e-commerce and mobile pay in consumption. Investment in digital software should increase and stimulate innovation to unbind the Chinese economy with foreign technologies. Thus, the upward trend of digital economy will continue, and have better effects in driving Chinese economy.

Funding

This work was supported by the project (21 SKGH 134); Research on harmonious labor relations thought of socialism with Chinese characteristics in the new era (2021YBCS39) (21SKGH141).

References

Cheng, Y., Zhang, Y., Wang, J., & Jiang, J. (2023). The impact of the urban digital economy on China's carbon intensity: Spatial spillover and mediating effect. *Resources, Conservation and Recycling*, *189*, 106762. https://doi.org/10.1016/j.resconrec.2022.106762

Garc á-Herrero, A., & Xu, J. (2018). How Big is China's Digital Economy? In *Brugel Working Paper*. https://doi.org/10.2139/ssrn.3429741

Heredia, J., Castillo-Vergara, M., Geldes, C., Gamarra, F. M. C., Flores, A., & Heredia, W. (2022). How do digital capabilities affect firm performance? The mediating role of technological capabilities in the "new normal". *Journal of Innovation & Knowledge*, *7*(2), 100171. https://doi.org/10.1016/j.jik.2022.100171

Huo, P., & Wang, L. (2022). Digital economy and business investment efficiency: Inhibiting or facilitating? *Research in International Business and Finance*, *63*, 101797. https://doi.org/10.1016/j.ribaf.2022.101797

Kolko, J. (2012). Broadband and local growth. *Journal of Urban Economics*, *71*(1), 100-113. https://doi.org/10.1016/j.jue.2011.07.004

Lechman, E., & Popowska, M. (2022). Harnessing digital technologies for poverty reduction. Evidence for low-income and lower-middle income countries. *Telecommunications Policy*, *46*(6), 102313. https://doi.org/10.1016/j.telpol.2022.102313

Li, Y., & Ranieri, M. (2013). Educational and social correlates of the digital divide for rural and urban children: A study on primary school students in a provincial city of China. *Computers & Education*, *60*(1), 197-209. https://doi.org/10.1016/j.compedu.2012.08.001

Liu, S., Koster, S., & Chen, X. (2022). Digital divide or dividend? The impact of digital finance on the migrants' entrepreneurship in less developed regions of China. *Cities*, *131*, 103896. https://doi.org/10.1016/j.cities.2022.103896

Myovella, G., Karacuka, M., & Haucap, J. (2020). Digitization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies. *Telecommunications Policy*, *44*(2), 101856. https://doi.org/10.1016/j.telpol.2019.101856

Ozturk, I., & Ullah, S. (2022). Does digital financial inclusion matter for economic growth and environmental sustainability in OBRI economies? An empirical analysis. *Resources, Conservation and Recycling*, *185*, 106489. https://doi.org/10.1016/j.resconrec.2022.106489

Reddick, C. G., Enriquez, R., Harris, R. J., & Sharma, B. (2020). Determinants of broadband access and affordability: An analysis of a community survey on the digital divide. *Cities*, *106*, 102904. https://doi.org/10.1016/j.cities.2020.102904

Song, Z., Wang, C., & Bergmann, L. (2020). China's prefectural digital divide: Spatial analysis and multivariate determinants of ICT diffusion. *International Journal of Information Management*, *52*, 102072. https://doi.org/10.1016/j.ijinfomgt.2020.102072

Yin, Z., Gong, X., Guo, P., & Wu, T. (2019). What Drives Entrepreneurship in Digital Economy? Evidence from China. *Economic Modelling*, *82*, 66-73. https://doi.org/10.1016/j.econmod.2019.09.026

Zhang, L., & Chen, S. (2019). China's Digital Economy: Opportunities and Risks. In *IMF Working Paper*. https://doi.org/10.5089/9781484389706.001

Zhou, A. (2022). Digital infrastructure and economic growth—Evidence for China. *Journal of Infrastructure, Policy and Development*, *6*(1), 1397. https://doi.org/10.24294/jipd.v6i1.1397

Zhu, W., & Chen, J. (2022). The spatial analysis of digital economy and urban development: A case study in Hangzhou, China. *Cities*, *123*, 103563. https://doi.org/10.1016/j.cities.2022.103563

Note

Note 1. Source: China Digital Economy Development Report 2022.

Note 2. Source: White Paper on China's Digital Economy 2020.