



A Comprehensive Evaluation of China's Digital Economy: A Comparative Study with the U.K. and the U.S.

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Abstract. As information technology continues to evolve, the digital economy will play an increasingly important role in the economic development of many countries. China is yet to catch up with developed countries, such as the U.K. and the U.S., as a latecomer in modeling its digital economy. This study identified the current challenges and proposed potential strategies to expedite the expansion of China's digital economy. Firstly, we inspected the current state of China's digital economy. Secondly, China's digital development was compared with that of the U.S. and the U.K., and the challenges of China's digital economy were elaborated.; Finally, targeted solutions were outlined. The study identified that the level of development of China's digital economy is lagging behind that of the U.K. and the U.S. in many aspects such as core technology, policy support, and industrial transformation. This study proposes feasible solutions in the following four elements: increasing investment in basic scientific research, reducing the hazards of the digital divide, strengthening the security of digital video privacy, and inviting overseas digital talents to enhance the core technology development.

Keywords: Digital Economy · International Comparison · Challenge

1 Introduction

With the continuous development in information technology, the economy is becoming more and more digitalized. Many countries have realized that the development of the digital economy is vital to achieving rapid economic growth, improving international competitiveness, and seizing the initiative of action. China is experiencing a boom in digitalization. However, there are still many risks and challenges in the development of the digital economy, which this study intends to examine. As the concept of the digital economy is quite vague, a rational understanding of how to develop it is required. To better promote the development of China's digital economy, it is helpful to compare it with the digital economy in developed countries so that strengths and weaknesses can be identified and targeted solutions can be suggested. In this study, we compared the digital economies of the U.S. and the U.K. and elaborated on the challenges confronting China.

Bukht and Heek's study defined the scope and concept of a digital economy. It also looked at the obstacles to the development of a digital economy to understand its impact on developing countries. They outlined the challenges in measuring a digital economy, such as blurred boundaries, poor data quality, pricing, and the invisibility of many digital activities. In addition, they posited that developing countries could achieve higher economic growth rates by exploiting the potential of their digital economies [1]. Voronkova et al. examined the theoretical and practical foundations of a digital economy, developed based on the philosophy of economics, using an interdisciplinary approach to gain a new scientific understanding. They concluded that a digital economy breaks the old order and rules of the game of industrial and post-industrial societies. Now, it has become an organic living being and has an existence of its own [2]. In addition, Volkova et al. examined the development of Russia's digital economy, identified its risks and challenges, and proposed strategies for further growth. They concluded that Russia's digital economy development is immature. However, as the country's leaders still attach great importance to it, it is necessary to develop cooperation between the state and enterprises [3].

Kim et al. investigated how big data can be used to help decision-makers make fact-based decisions to improve performance or develop better strategies. They also focused on big data applications that can support operational decision-making, including advanced research on decision-making models and tools for a digital economy. They concluded that the internet of things (IoT) and big data offer enormous possibilities for businesses to improve their operational performance and that emerging technologies are most effective at developing the digital economy [4]. Bukht and Heek's found that a digital economy is crucial for developing countries. However, there are many practical challenges for these countries on the road to achieving their developmental potential. They outlined these challenges and present solutions, and proposed policy measures, processes, and structures necessary to promote digital economic growth [5]. Milošević et al. created a measure for digital economic performance using the composite I-distance indicator (CIDI) approach and ranked the European Union countries (EU-28) based on their digital performance. They concluded that the digital economy of Denmark, Sweden, and the Netherlands is significantly more advanced than that of others and that the digital transformation of the E.U. still has a long way to go [6].

Garifova's study examined the impact of information technology and information accumulation on economic growth and the promotion of enterprise competitiveness in the era of the digital economy. He concluded that to remain competitive and profitable during a period of significant information transformation, corporate management must learn to use the company's information to create new products and services or even a new market [7]. Yin et al. studied the effect of mobile payment on family entrepreneurship. They used a two-stage least squares regression to address endogeneity in mobile payments. They found that mobile payments significantly increase the likelihood of home entrepreneurship. Because mobile payment improves payment efficiency, increases the convenience of payment, and enlarges the dissemination channels of product information, it indirectly causes an increase in consumption. Therefore, as a convenient payment and financing tool, mobile payment benefits entrepreneurship from market production and consumption points of view [8].

Drahokoupil and Jepsen focused on the transformative effects of digitization of the economy on the overall labor market. They also examined other platforms that have an equally different impact on the labor market. After reviewing the results of previous studies, they concluded that media could inject vitality into the labor market, but it also carried risks. They considered the platform economy to be both a challenge and an opportunity [9]. Dahlman et al. examined why a digital economy is essential for developing countries. The digital revolution's impact on developing countries is critical because they can learn from other countries. They also provided guiding principles for developing a national digital strategy [10].

This study focused on the challenges and risks in the development of China's digital economy and compared it with that of the U.S. and the U.K. to formulate workable solutions. Based on a literature review, this study presents three research objectives. The first objective is to summarize the current state of development of China's digital economy, outline the characteristics of the digital economy in the U.K. and the U.S., and make a benchmark comparison. The second objective is to identify China's digital economy growth challenges. The third objective is to explore solutions and measures to address its current challenges.

2 A Comparison of Digital Economy Development in China, the U.S., and the U.K.

2.1 Current State of China's Digital Economy

The COVID-19 pandemic has had a significant impact on the economy in China. Traditional industries, such as tourism, catering, and transportation, are undergoing a recession, and the lockout of the manufacturing industry has brought significant uncertainty to imports and exports. However, the digital economy has shown remarkable resilience under these circumstances and has emerged as a new force to stabilize China's economy. The data sources for the following analysis are shown in Figs. 1 and 2. The data released by the China Information Institute indicates that China's digital economy continues to grow and reached \$5.4 trillion in 2020. The proportion of the digital economy in its GDP is also steadily rising, accounting for 38.6% of GDP in 2020 [11]. These figures show that China's digital economy is becoming increasingly prominent in its national economic development. This was contributed partly by the favorable policies. In recent years, the Chinese government introduced a series of measures to promote the development of the digital economy and put it on the national agenda. In the latest "14th Five-Year Plan" for the development of the digital economy, the government has put forward the goals of optimizing and upgrading infrastructure, consolidating the foundation of growth, promoting digital transformation of industries, and augmenting the development momentum to encourage deeper integration of digital technology with the physical economy and expand the space for economic development. To this end, the 2022 East-to-West Computing Capacity Diversion Project was launched. The project aims to build a new arithmetic network system that integrates data centers for cloud computing to orderly channel the data processing demand from the country's prosperous but land-scarce eastern regions to the underdeveloped but land-sparse western areas. This

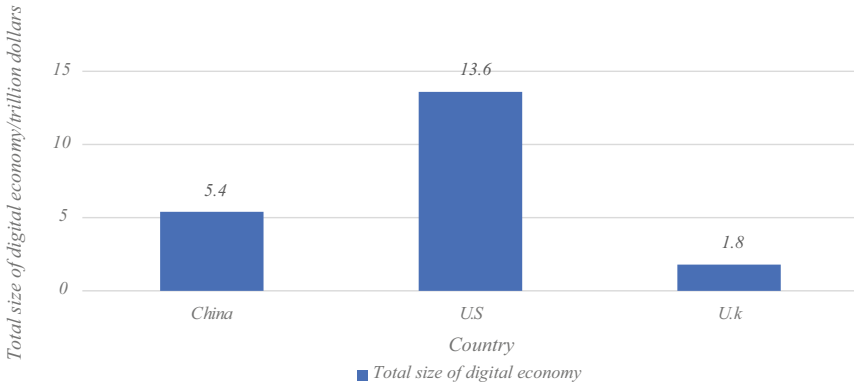


Fig. 1. The total size of the digital economy in China, the U.S., and U.K.

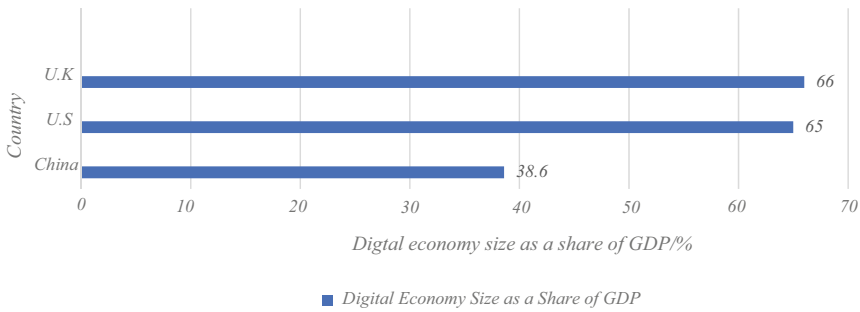


Fig. 2. China, U.S., and U.K. Digital Economy Size as a Share of GDP

will balance the layout of data center construction and enhance the synergistic linkage between the east and west so that the computing power in west China can be maximized to fully satisfy the data analysis demand in east China. This is a new milestone project in the development of China’s digital economy.

Note: The data on the size of the digital economy in China, the U.S., and U.K. are from the Global Digital Economy White Paper (2021) published by the China Academy of Information and Communications Technology.

2.2 Comparison of China’s Digital Economy Development with the U.S.

The U.S. GDP downtrend by 3.5% in 2020 because of the COVID-19 pandemic. Despite the economic recession, the scale of the U.S. digital economy scale topped globally at \$13.6 trillion. The digital economy constitutes 65% of its GDP,[11] which shows the robust potential of the digital economy in the economic recovery. The pandemic provided a new opportunity to shape the digital economy ecology. While the overall size of China’s digital economy is second only to America, a significant gap is present between the two countries. The U.S. holds the unshakeable advantage in terms of core technology and industrial integrity. The U.S. is the birthplace of the first electronic computer, the first

transistor, and the first integrated circuits. According to the market research agency I.C. Insights, out of the top ten global semiconductor manufacturers in 2021, six were American. Two were Taiwanese, whereas Mainland China has none. More than that, nearly all the significant introductions to the digital economy can be traced back to the United States. American companies dominate the digital economy, from manufacturing chips to operating systems and powerful application software.

China is a latecomer to the digital economy, with significantly lagging behind core technologies and production processes. The digital economy is only contributing to 38.6% of China's GDP. One reason for this is that the U.S. holds almost all the critical components in the whole field. China relies heavily on foreign machines and technologies. China has so far minimal innovation in the digital economy, such as the Internet plus.

Regarding relevant policies, the U.S. government attaches great importance to the research and development of advanced technologies to maintain the leading position in the digital economy. It has promoted the development of chips, A.I. technologies, new communication technologies, computers, and other related fields by introducing talents, capital, and project cooperation. The U.S. Congress passed the American Innovation and Competition Act in 2021, under which the government plans to invest about \$250 billion in A.I. technology, chip research and development, and electronic communications in the digital economy in the next five years. The U.S. government seeks to apply internet technology to the entire industrial chain, using the country's technological and financial advantages to scale up its digital economy in depth and breadth. In contrast, as previously mentioned, China has also drawn up the objectives of its digital economy in its latest 14th Five-Year Plan and plans to promote the digital transformation of industries. Successful implementation may help narrow the digital economy gap in these two countries.

2.3 Comparison of China's Digital Economy Development with the U.K.

As the origin of the modern industrial revolution, the U.K. has a unique advantage in receptiveness to new technologies. When the digital era started, the U.K. was one of the first countries to initiate digital reform. In 2020, the full scale of its digital economy reached US\$ 178.84 billion, fifth in the world, accounting for 66% of its GDP[11]. Similar to the U.S., it has a first-mover advantage in many areas. Earlier in 2017, the U.K. government laid out its digital strategy to create an economic form that could adapt to change. In 2020, it enacted the National Digital Strategy with a clear set plan.

The U.K. actively promotes digital government reform and has created single-point access to government services through the GOV. UK initiative. It is a service and information network for all government departments. China is still in the early stages of digitalizing its government services and does not have a single platform for digital government services. However, China's digital governance capabilities are improving, and the national integrated government platform is improving. The British online gaming industry prospered during the pandemic, with more people entering the online gaming market because of the quarantine and lockdowns. The growth in related products such as headset gamepads is even faster. The size of the U.K. gaming industry exceeded \$6.1 billion, the highest in Europe. In contrast, China's digital gaming market was about \$43 billion in 2020, with a year-on-year increase of 20.71% and 665 million users[12].

China is rapidly becoming the world's largest digital gaming market and has a substantial competitive advantage.

3 Challenges Facing China's Digital Economy

Through the above comparison of China's digital economy development with that of the U.K. and the U.S. and the constraints of its conditions, it can be seen that China faces many challenges in the new wave of technological revolution. Specifically, they are manifested in the following points.

3.1 Polarization Caused by the Digital Divide

The digital divide refers to the gap between people who have adequate access to information communication technology (ICT) and people who have poor or no access to ICT.[13] Since the emergence of the internet, the digital divide has been an essential topic in internet governance. It centers on how to provide more information technology infrastructure to allow more users to access the internet. The new round of technological revolution represented by 5G, A.I., blockchain, and quantum technology has dramatically sped up the application of digital technology—a new digital divide that is broader in scope and more dramatic in extent. With the continuous development in digital technology, many groups of the population cannot keep pace, resulting in the new digital technology being grasped by only a few people and decreased information sharing. This gives rise to social inequity.

3.2 Scarcity of Digital Talent

The driving force for advancement in digital reform is the development of new technologies and concepts. This has led to an increased demand for top-notch talents in China. As an old industrial powerhouse, the U.K. has several world top universities, such as Cambridge and Oxford, where many engineers and data scientists with a high level of education and strong research capabilities graduated from. These high-end talents add tremendous value to the development of the digital economy. The U.S. is also among the world's best in higher education. It also attracted many immigrants who assisted greatly in shaping the digital economy. According to the 2019 list of Fortune 500 companies, nearly half (44.6%) of those big U.S. firms have first-generation (101/223) or second-generation immigrants[14]. China currently faces a severe shortage of high-level skilled workforce in the digital economy. Urgent re-adjustment is needed in the digital talent strategy. The specific way the digital talent is trained needs to be learned.

3.3 Data Privacy Issues

With the rapid development of the digital economy, the internet collects more personal data to feed its growth. However, this simultaneously poses the risk of a privacy breach. The U.K. introduced the Data Protection Act in 2018, and the state of California in

the U.S. passed the California Consumer Privacy Act in 2018 to comprehensively protect consumers' privacy. China's data privacy protection system is currently immature. Although it has proposed a personal information protection law, there are many barriers to implementing the law. One of the issues is the need to balance data use and information security. In the era of big data, various internet services have to collect user information to provide better services. Users typically do not read the data privacy agreements prior to providing their personal information to quickly obtain the benefits/services. The data is often passed on to various third parties to meet users' needs, and there is easily a privacy breach. More strict policies and regulations are demanded to ensure data privacy and balance of data use and privacy.

3.4 A New Wave of Unemployment

As a new industry, the digital economy has both pros and cons. It will create some new jobs on the bright side. However, the downside cannot be underestimated. The first problem is the relative lack of government regulation in this sector. The employment model of the new industry may affect the traditional industries and disrupt the social security system. There are many legal blind spots in the digital economy regarding contracts. Unlike the traditional industries, the digital economy is characterized by the freedom to hire and fire employees, resulting in many disputes. The highly flexible employment may also affect the appropriate payment of social security funds and personal income tax, interfering with reasonable income distribution. Moreover, the digital economy could lead to structural unemployment. Take the manufacturing industry as an example. With the constant advancement in A.I., robots may eventually replace assembly-line workers. When these positions are eliminated, the unemployment rate will increase. Re-employment is usually difficult before these groups of workers can master a new skill set. The same is true for e-commerce, where online stores are replacing a lot of brick-and-mortar stores and information salespeople with specialized skills adapted to the digital economy driving ordinary salespeople out of business.

4 Solutions to Guarantee a Stable Development of the Digital Economy

China is currently in a period of rapid development of the digital economy. In such a context, it is essential to rationally understand the risks and challenges confronting the development of the digital economy. The following strategies are proposed based on the abovementioned challenges faced by China's digital economy and the existing disadvantages compared to the U.K. and the U.S.

4.1 Increasing Investment in Technology Research and Development

The technological update is critical for the remodeling of the digital economy. The U.S. and U.K. lead the world's digital economy mainly because they produced and patented the core technologies and machines. The last round of digital development was the creation of the mobile internet. Therefore, the development of a new digital economy

needs technological breakthroughs. A workable suggestion is to increase investment in basic research. Compared with other developed countries, China's investment in basic R&D is low, rendering its independent innovation and technology development capability insufficient. Statistics show that China's fundamental research investment accounts for only 6% of R&D investment, far below the level of 15% to 25% in the United States, the United Kingdom, France, and other developed countries; corporate fundamental research investment is also seriously inadequate, with corporate fundamental research spending in the United States accounting for about 28% of society as a whole, while China accounts for only 2.9%. [15].

4.2 Alleviating the Digital Divide

The digital divide originated from the difference in people's access to information and network technology. Therefore, the best approach to alleviate the digital divide is to narrow the information gap. The first step is to develop more digital technologies that ensure disadvantaged groups enjoy the benefits of the digital economy. For example, the elderly are most vulnerable to the digital divide, as they are unable to keep up with modern technology. Developing easy-to-use smartphones can give them a quick start. An alternative way is to design apps or services suitable for the elderly. Second, greater digital literacy should be provided with the constant hardware upgrade. Strengthening capacity building and advocating a learning environment is helpful for all users. The government and society can offer more education and training resources to encourage different user groups to break the digital divide respectively.

4.3 Improving Data Privacy

The following are the suggestions to help reduce data leaks effectively. First of all, the data leak problem can hardly be solved in its entirety. Users' private data should be managed hierarchically. This was also mentioned in the data security law announced in China in 2022. To carry out hierarchical data protection, the user's identity with various other aspects, such as gender, age, and occupation, should be considered. The children's data should be labeled as sensitive and divided by the content of data privacy. Sensitive data, such as religious beliefs, political views, and health and biometric data, which can seriously compromise personal safety with information leaks, should be protected from data privacy to avoid being collected and abused. After that, new laws and regulations should be introduced to counter the illegal collection of data and privacy abuse through legal loopholes. Last but not least, users should be educated and made aware of the importance of personal privacy protection and network security and privacy, such as carefully reading privacy agreements on websites to prevent data from being collected without their awareness.

4.4 Producing a Skilled Workforce

China's current digital talent training system is outdated and has not kept pace with the current technological development. Therefore, it is necessary to analyze and study the

requirement of digital talents in the digital economy. A tri-pronged coordination by the government, schools, and enterprises is required to research and explore the ways and means of training talents based on the demand of the digital economy. The government should strengthen its primary education and policy and continuously improve the education and training system to provide adequate growth resources and career paths for data scientists and engineers. Enterprises can provide digital talents with a suitable research environment and free space to develop, as well as resources to solve practical problems. Schools need to focus on integrating new technical knowledge relevant to the digital economy into the curriculum. Schools are also expected to recruit excellent Chinese and overseas teachers to help innovate the curriculum model. Close cooperation with digital economy enterprises will help set up digital talent training programs and curriculum systems according to actual needs. The graduating students trained can then best match the needs of enterprises and reduce the risk of graduates' unemployment [16].

5 Conclusion

Although China has rapidly developed its digital economy, it still lags behind the U.S. and the U.K. China has a vast market, but its digital economy is only half the size of the U.S. Both the U.S. and the U.K. have advanced core technologies, and both have introduced regulatory measures for a more comprehensive digital economy development, while China is still a pretty early stage on this front. Data privacy protection, information security, the digital divide, and structural unemployment due to digitalization are some of the challenges confronting China. In response to these developing risks and challenges, this paper proposed several targeted solutions. First, increasing investment in basic research and gradually getting rid of the dependence on the foreign technology/infrastructure as early as possible. Second, eliminating the digital divide and helping more groups adapt to the digital society. Third, implementing the relevant regulations of personal information security and privacy protection to guarantee the healthy development of the digital economy.; Fourth, empowering the research environment, innovating the education system, and bringing in talents from all over the world to help cultivate more technical talent to meet the development needs. This paper is aimed at analyzing China's digital economy by competitive benchmarking with the US and the UK. A Follow-up study on the evolution of the digital economy landscape in these three countries will help understand how the abovementioned policies help remodel the digital economy.

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