Research article

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Connotation and Development History of Digital Economy

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Abstract

With the spread of the COVID-19 pandemic, the digital economy has become a new engine of global economic growth, and new industries and economic models will continue to emerge. The digital economy has become a strategic high point of competition among countries and a new driving force of global economic growth in the new era, and all countries in the world are facing an important strategic opportunity period. This paper shows the value and potential of the digital economy by theoretically summarizing and analyzing its basic connotation, including its basic definition, development history, dissemination mechanism, and development law. The study released by the United Nations Conference on Trade and Development concluded that the epidemic crisis has intensified the digitalization process of the whole society, and the use of digital solutions, tools, and services has brought positive economic growth, which has also inspired many countries to find new breakthrough points for economic growth and accelerated the transformation of the global economy to digitalization. The digital economy in the post-crisis era will continue to accelerate this trend, and the underlying trends of the global digital economy will further strengthen, which will bring profound impacts and changes to digitally vulnerable countries. This presents an important research direction for studying the digital economy to enhance ESG development today.

Keywords: digital economy, development trend, information economy, network economy, smart economy

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Значение и История Развития Цифровой Экономики

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Аннотация

С распространением пандемии COVID-19 цифровая экономика стала новым двигателем глобального экономического роста, в связи с чем будут постоянно появляться новые отрасли и экономические модели. Цифровая экономика стала стратегической точкой соперничества между странами и новой движущей силой глобального экономического роста в новую эпоху, и все страны мира сталкиваются с периодом важных стратегических возможностей. В этой статье показана ценность и потенциал цифровой экономики путем теоретического обобщения и анализа ее основного значения, включая ее базовое определение, историю развития, механизм распространения и закон о развитии. В исследовании, опубликованном Организацией Объединенных Наций по торговле и развитию, сделан вывод о том, что эпидемический кризис активизировал процесс цифровизации всего общества, а использование цифровых решений, инструментов и услуг привело к положительному экономическому росту, что также вдохновило многие страны на поиск новых точек прорыва для экономического роста и ускорило переход глобальной экономики к цифровизации. Цифровая экономика в посткризисную эпоху продолжит ускорять эту тенденцию, а развитие глобальной цифровой экономики будет усиливаться, что приведет к глубоким последствиям и изменениям в странах, уязвимых в цифровом отношении. Данная тема представляет собой важное направление исследований для изучения цифровой экономики с целью повышения эффективности развития других направлений, например, ESG.

Ключевые слова: цифровая экономика, тенденции развития, информационная экономика, сетевая экономика, умная экономика

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1. Introduction

The concept of the digital economy is now widely used and studied. The definition of the "digital economy" is not a simple matter. According to a literature search, a considerable number of scholars attempted to define the digital economy from 1996 to 2018. With the development of Internet technology and the industrial economy, rapid changes in digital technology have led to changes in the economy of the world, the connotation of the economy has been enriched, and the boundaries have become increasingly blurred. Therefore, there is a need for an accurate redefinition of definitions. By collecting and collating literature on the understanding of the digital economy from the perspectives of governments and economic organizations in China, the US, Russia, Japan, the EU, and the OECD, we attempt to offer some generalizations about the changing understanding of the digital economy across countries. In addition to the origins and dissemination of the concept of the digital economy, research results, and issues, we also analyze the relationship between the digital economy and other related concepts, arguing that the essence of the digital economy is production by means of digital technology, which accurately reflects the essential characteristics of this economic form.

2. Literature review

Against the backdrop of slowing economic growth in countries around the world, the digital economy has shown vigorous development. According to Wenjun and Baowen (2019), the rapid development of the digital economy can provide a better matching mechanism and innovative power for the construction of China's modernized economic system. On the basis of sorting out the characteristics of China's development, the relationship between the digital economy and economic growth and its inner mechanism for promoting high-quality economic development are discussed at the micro and macro levels. Heping and Fuxiang (2021) constructed an evaluation system based on the dimensions of development environment, digital industrialization, industrial digitization, and digital governance, measured China's digital economy development index from 2016 to 2018 through the TOPSIS method, and put forward suggestions for a digital economy to promote high-quality economic development in China. Jiang (2022) discussed the value ontology of the digital economy in terms of both form and substance, distinguished the different meanings of "creating new value" in the industrial economy and in the digital economy, and separated the value ontology of the digital economy from the general exchange value. Yu (2021) analyzed the impact of four types of industrial policies—government subsidies, tax preferences, credit loans, and industry access systems—on industrial technology innovation in the digital economy using patent and financial data from digital economy listed companies in Shanghai and Shenzhen A-shares from 2008 to 2017. The results showed that government subsidies and industry access systems are still the more significant industrial policies affecting industrial technology innovation in the digital economy. There is industry heterogeneity in the influence of industrial policies on technological innovation in digital economy industries. Both government subsidies and credit loans can enhance the innovation ability of enterprises by increasing their R&D investment, while industry access systems and tax incentives can also enhance the innovation ability of enterprises by increasing their profits. Using Chinese household tracking survey data, He and Song (2016) empirically analyzed the impact of digital economy development on individuals' employment decisions. The results reveal that the digital economy dividend benefits the more educated group and helps alleviate the constraints of borrowing and insufficient resources for social connections for individual entrepreneurship, which can significantly facilitate their employment decisions. Gospodarik and Kovalev (2020) and Li and Gospodarik (2022) analyzed the main issues related to economic growth and the benefits associated with the implementation of digital economy innovation breakthrough scenarios in Eurasian Economic Union member countries through hybrid forecasting models and consensus forecasts. A study of the literature related to informatization, digital economy, and economic growth in China, Japan, Korea, Brunei, and Cambodia in the Asia-Pacific region revealed that the share of the digital economy is increasing in each country, and the development of the digital economy has a positive impact on economic growth (Rong, 2021).

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3. The Challenge in Defining the Digital Economy

3.1 The connotation of the digital economy

A. Origin and definition of the concept of the digital economy

It is not a simple task to define the "digital economy". According to a literature search of publications from 1996 to 2022, many scholars have attempted to define "digital economy". The difficulty in defining the concept is mainly due to the constant acceleration of the evolution of its structure, mechanisms, scale, and technological base, and the highly influential and driven changes in economic organization, economic systems, and even business models. In short, the digital economy is an extremely dynamic and increasingly complex concept. Moreover, traditional economic concepts are no longer adaptable to the digital economy. For example, the factors of production and cost concepts of the digital economy have drifted away from the traditional economy, and are even very different from it.

B. Early definition of the digital economy in various countries

The concept of the digital economy has been around for a long time. With the development of Internet technology and the industrial economy, it has been increasingly used and more widely, and the research on the connotation of the digital economy has also been enriched. However, the problem of unclear definitions of the connotation and confusion in the use of the concept remains. The definition of the digital economy varies from country to country, and the phrase "digital economy" first appeared in 1994. In 1996, the term first entered the industry literature, and in 1996, Don Tapscott, an American information technology (IT) consultant, published "The Digital Economy: Promise and Peril in the Age of Networked Intelligence", which not only highlighted "digital economy" in the title of the book, but also described various aspects of the digital economy in detail. Don Tapscott has been recognized as the "father of the digital economy". In 1999, Nicholas Negroponte, the founder of the MIT Media Lab, proposed a more influential definition, describing the digital economy as an economy of "from atoms to bits". This definition illustrates the network-based nature.

To promote the development of the digital economy, governments have begun to offer their own understanding of the concept of the digital economy. The first country to define the digital economy was Japan in the May 1997 report, in which the digital economy is one with four characteristics: it is possible without the physical movement of people, objects, and money; it electronically accomplishes contracting, value transfer, and asset accumulation; it allows the development of IT, which is the foundation of the economy, at a rapid pace; and it supports the broad expansion of electronic commerce. From this definition, it is clear that the Japanese government describes the digital economy as electronic commerce in a broad sense. In the 1990s, the US economy experienced high growth, low inflation, and low unemployment, which most people attributed mainly to the application of IT. In 1998, the US Department of Commerce released The Emerging Digital Economy, a report on the digital economy that captured e-commerce and the IT (information technology) industry that makes e-commerce possible as two aspects of the digital economy (see Table 1, Henry et al., 1999). Specifically, e-commerce is a means of conducting transactions, whereas the IT industry is the engine of change in the digital economy and the foundation that supports e-commerce. In October of the same year, the US Bureau of Statistics further proposed a specific scope of the digital economy based on this definition, which includes inter-networking, e-commerce, e-enterprise, and online transactions, and gave specific definitions accordingly. The US definition of the digital economy focuses on the digital economy as the sum of measurable e-commerce and IT industries (Mesenbourg, 2001). The US judged the arrival of the digital economy from the government's perspective and began to design measurement indicators, collect data, and include the digital economy in official statistics. Emerging Digital Economy II and Digital Economy 2000 were released one after another (Buckley, 1999, 2000). The concept of the "digital economy" has been widely used in society since then.

Table 1. US Department of Commerce Digital Industry Classification (1998)

Digital Industry	Industry Content	Digital Industry	Industry Content
Hardware manufacturing	Computers and computer equipment Computer wholesale and retail trade office computing equipment Optical and magnetic recording equipment＊★ Electronic tubes Printed circuit boards Semiconductor-related equipment Passive electronic components ★ Industrial measurement instruments Current measurement instruments and laboratory analysis instruments	Software and Computer services	Computer programming services Pre-installed software※ Software wholesale and retail trade Computer system design Computer data processing Information retrieval services* Computer service management※ Computer rental and repair Other computer-related services
Communication equipment manufacturing	Home audio-visual equipment★ Telephone equipment Radio and television communication equipment	Communication service industry	Telephone communication Broadcasting industry※ Television industry※ Cable TV and other pay TV services※

Source: Buckley et al., 2000

Note: ★ represents new industries or the change of industry name, ※ is the change of industry classification, ＊represents the deleted industries.

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Table 2. US Department of Commerce digital industry classification criteria (2002)

Digital industry	Industry content	Digital industry	Industry content
Hardware manufacturing	Computers and computer equipment Office computing equipment Computer wholesale and retail trade Electronic tubes Printed circuit boards Semiconductor-related equipment Various electronic components a★ Industrial measuring instruments Current measurement instruments, laboratory analysis instruments	Software and computing services	Pre-installed software※ Software wholesale and retail trade Computer system design Computer data processing Information retrieval services* Computer service management※ Computer rental and repair Other computer-related services
Communication equipment Manufacturing	Audio-visual equipment★ Telephone equipment Radio and television communication equipment Optical fiber★ Software replication★ Optical and magnetic recording equipment ✶	Communication Services	Telephone communications Broadcasting industry※ Television* Cable TV and other pay TV services※

Source: Margherio, Lynn, et al. The emerging digital economy.

Note: ★ represents new industries or the change of industry name, ※ is the change of industry classification, ✶ represents the deleted industries.

Rapid changes in digital technology have led to rapid changes in the scope of the digital economy. A comparison of Table 1 and Table 2 of the US Department of Commerce's 1998 and 2002 digital industry classification standards shows that more than 20 industries covered by the digital economy have undergone more than a dozen changes in just four years. Industries such as fiber optics, software publishing, software replication, programming services, equipment management, cable, and satellite communications were added to the digital economy, and industries such as radio, television, and information retrieval services were removed. The structure of the digital economy has made it quite difficult to define it by industry, and the human economic ecology has changed like never before. At almost the same time, the development of big data, cloud computing, artificial intelligence, and the creation of instant messaging software, such as Facebook, Telegram, and WeChat, have made the form of the Internet economy more diverse. Second, the iterative development of search engines (such as Google, Yandex, and Baidu) has significantly improved the comprehensiveness and accuracy of the query, the development of search engines to help the original e-commerce, and its own application boundaries are blurred.

Lastly, the rapid development of the mobile Internet has made the economic forms covered by the digital economy expand again, and the opening of geolocation-based services has injected new momentum into the economy. The new economic forms represented by the sharing economy have also joined the ranks of the digital economy.

C. Definition of digital economy by various countries and organizations nowadays

The term digital economy is currently used everywhere in government, industry, academia, and the media to describe the economic phenomena arising from the IT revolution. A search for "digital economy" in Google found 7.92 million results (June 25, 2022 search), and a search for the same term in Baidu found 1 million results (June 25, 2022 search). The OECD has been measuring the digital economy for many years and uses the digital economy in the titles of its reports, such as the OECD Digital Economy Outlook 2020[1]. The rising difficulty in defining the digital economy has led to a divergence of definitions across countries, but almost all stakeholders agree that the digital economy is an economic form brought about by IT and informatization, which is common to current research across countries. Research scholars in all countries agree that IT and informatization have brought about a digital economy. For example, Chohan U. argued that the digital economy, based on the economy of digital computing technology, is a business conducted through the marketplace based on the Internet and the World Wide Web (Chohan, 2020). According to Zhou X et al. (2022) the economy in which various social activities are based on the numbers of 0 and 1, which can be used to describe the flow of numbers dynamically, is called digital economy. According to Zhao Y. and Wang Zh. (2003), the digital economy is based on information and communication technology. Through the Internet, mobile communication networks, and the Internet of Things (IoT), the digitalization of transactions, communication, and cooperation has been realized to promote the development and progress of the economy and society (Jian and Xinmin, 2013). Deloitte reported in 2020 (Cassar et al., 2020) that it is based on the interconnection of people, organizations, and machines generated by the Internet, mobile technologies, and the IoT, which originates from billions of daily online connections between people, businesses, devices, data, and processes. The OECD (2014) considers the digital economy to be underpinned by the spread of ICT across all business sectors to enhance productivity.

China, Korea, and Russia all perceive the digital economy as an economic activity, although with different emphases. China proposed in the 2016 G20 Initiative on Digital Economy Development and Cooperation that "the digital economy refers to a series of economic activities in which the use of digital knowledge and information is a key factor of production, modern information networks are an important carrier, and the effective use of ICT is an important driving force for efficiency improvement and economic structure optimization", emphasizing that the digital economy is a collection of information and communication main industries and industrial integration. The National Bureau of Statistics[2] of China in G20 and the CPC Central Committee's proposals for formulating the 14th Five-Year Plan (2021-2025) for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 released the "Statistical Classification of Digital Economy and Its Core Industries (2021)". Russia, by contrast, specifies in its definition that the digital economy is an economic activity that safeguards national interests. The Russian Federation has published the "Digital Economy Plan of the Russian Federation"[3], in which it defines the digital economy as an economic activity that uses digital or ITs in production, management, administration, and other processes for the purpose of ensuring the national interests of the Russian Federation, including the improvement of the standard of living of the population and the competitiveness of the national economy. In Korea, the definition is more general and directly describes the digital economy as all economic activities based on the information and communication industry, including the Internet. This includes electronic transactions, Internet shopping, search services, etc.

The US, France, and the OECD, however, still place their focus on the measurement of the digital

[1] OECD Digital Economy Outlook 2020. Available at: https://www.oecd.org/sti/ieconomy/oecd-digital-economy-outlook-2020-bb167041-en.htm

[2] The National Bureau of Statistics, Statistical Classification of Digital Economy and Its Core Industries, 2021. Available at: http://www.stats.gov.cn/tjsj/tjbz/202106/t20210603_1818134.html

[3] On the approval of the program "Digital Economy of the Russian Federation". Available at: http://government.ru/docs/28653/

economy. On November 18, 2016, the US Bureau of Economic Analysis Advisory Committee stated in its showcase report Measuring the Digital Economy that measuring the digital economy should include, in addition to the e-commerce component, new digital services, such as the sharing economy, such as shared rides and advertising-supported free Internet services. France defines the digital economy from an industry perspective. The Digital Economy Monitoring Center under the French Ministry of Economy and Finance defines the digital economy as industries that depend on information and communication technologies, while the French Digital Economy Association considers the digital economy to include the telecommunications industry, the audiovisual industry, the software industry, the Internet industry, and those industries that need to use telecommunications, audiovisual, software, and Internet technologies to support their own activities. The OECD continues to define the digital economy as trade in goods and services enabled and conducted through electronic commerce (Strassner and Nicholson, 2020).

The UK focuses on understanding the digital economy in terms of output and considers the digital economy as the creation of socio-economic benefits through complex relationships between people, processes, and technologies. The "digital economy" refers to the total economic output generated by various types of digital inputs. Digital inputs include digital skills, digital devices (hardware, software, and communication devices), and digital intermediate goods and services used in the production chain. On December 19, 2018, Australia's Department of Industry, Innovation and Science released a strategy report entitled "Australia's Tech Future – Delivering a strong, safe, and inclusive digital economy", a strategic report designed to enable Australians to enjoy the improved quality of life enabled by technology, involve businesses to seize the opportunities of a rapidly growing modern economy, and compete globally. It sets out the measures needed to develop a strong digital economy in Australia in seven areas: skills, inclusion, digital government, digital infrastructure, data, cybersecurity, and regulation[4].

Most developed countries have recognized the importance of the digital economy earlier and have made a strategic layout of it. The US was the first country in the world to lay out the digital economy, and in the 1990s, the Clinton administration launched the "information superhighway" strategy, focusing on big data, artificial intelligence, smart manufacturing, and other areas to promote the development of the digital economy as the key to achieving continued prosperity and maintaining competitiveness. The UK was the first country to introduce a digital economy policy, releasing Building Britain's Future Plan in 2009, which was the first time digitalization appeared in the form of a national top-level reality. Subsequently, all countries have started to implement various strategies for the development of the digital economy according to their own definitions, although developing countries have lagged behind in the layout of the digital economy, and most of them have only started to lay out relevant strategies in recent years.

It is difficult to define the digital economy specifically, mainly because the evolution of the structure, mechanism, scale, and technological base of the digital economy is constantly accelerating and highly influencing and driving changes in economic organization, economic systems, and even business models. The concept of a traditional economy has been difficult to adapt to the digital economy. In the 1990s, it was easier to distinguish between the digital economy and the non-digital economy, but now it is increasingly difficult to make such a distinction. In the past half century, the digital economy has undergone a transformation from being insignificant in the traditional economy to occupying half of it. Now, the digital economy is entering a new stage in the history of transforming the traditional economy, and the general trend is that on the one hand, the scale of the digital economy is expanding, and on the other hand, the traditional economy is digitizing; it is somewhat analogous to a "solar eclipse", in which a new economy covers the traditional economy (Fig. 1).

[4] Digital Economy Act, 2010. UK Public General Acts. Available at: http://www.legislation.gov.uk/ukpga/2010/24/contents

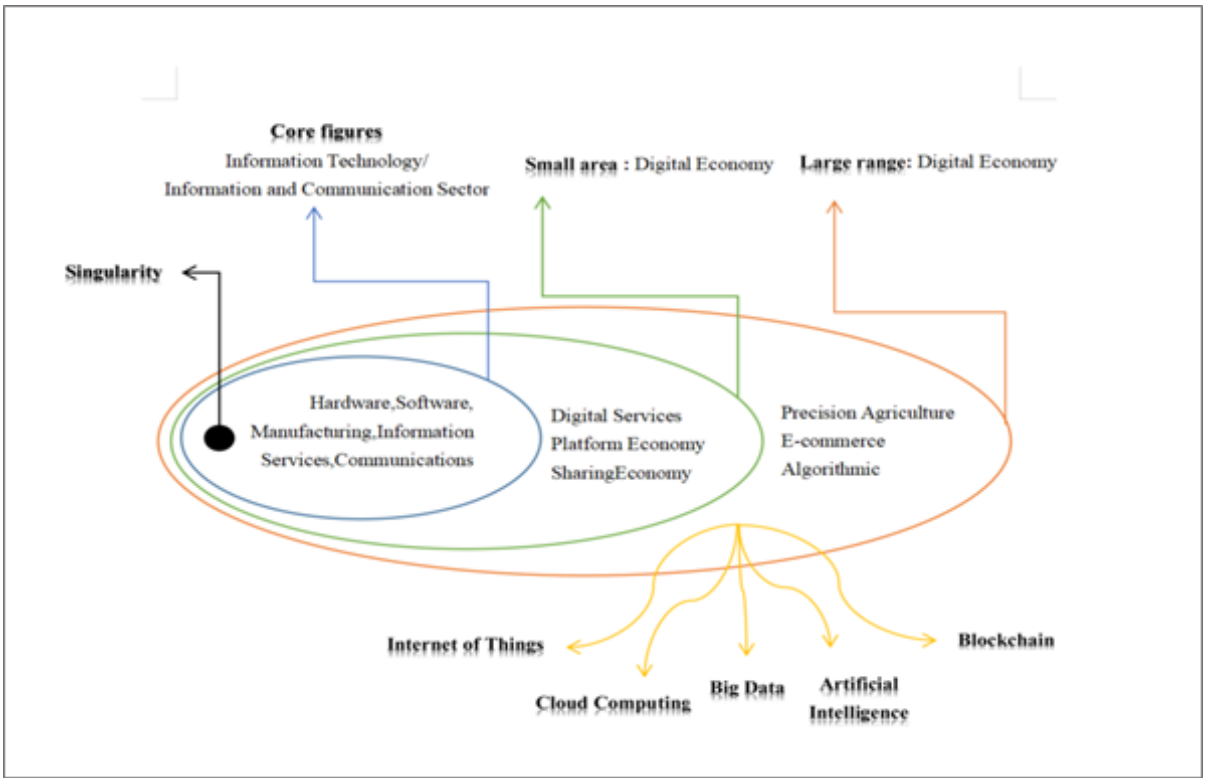

Figure 1. Conceptual evolution of the digital economy

Source: compiled by the authors

3.2 Digital economy development history

As a new economic model, the digital economy is the most important economic form, after the agricultural economy and industrial economy. It can be traced back to the information economy that emerged around the 1940s, which has experienced more than 70 years of development and has had a profound impact on the world's economic, political, and technological landscape. By combining the history of the development of the digital economy, we find that the development of the digital economy can be roughly divided into four stages.

A. The budding stage of the digital economy

In 1946, the US Department of Defense developed the world's first general-purpose computer, the ENICA, marking the official start of the digital economy. In the mid-1950s, the emergence of transistors led to the development of miniaturized computers, and in 1954, IBM built the first computer using transistors. In the mid-1960s, the invention of integrated circuits led to a revolution in circuit design, and in 1964, IBM developed the first general-purpose electronic computer using integrated circuits, the IBM 360. In 1971, Intel developed the world's first microprocessor, 4004, and the era of microcomputers based on microprocessors began. The software also appeared in standardized programming language, human-computer conversational BASIC language, and so on. From the technical development characteristics, with the progress of integrated circuit design and processing capabilities, the rapid development of computer core processing and storage technology, the size of the computer continues to shrink, the price also continues to decline, the reliability of enhanced, and faster computing speed. During this period, IBM and Hewlett-Packard occupied most of the market share of mainframe computers and minicomputers, respectively.

B. The first singularity of the digital economy explosion (1961–2008)

Compared with the traditional non-digital economy, the process of digital economy generation is peculiar. The starting point was neither material, labor, nor production, but ideas, and the idea that such

ideas could lead to a new economic form is called "singularity". At that time, there were already two types of information and communication in the world. In the United States, for example, AT&T was already a very large company, supporting a huge world communications network. However, there was a limit to the amount of information that could be transmitted by either telegraph or telephone. When the telephone is overloaded, occupied lines and busy signals occur. Obviously, new ideas are needed to solve the communication problem of information. For example, is there a way to decompose large-scale information, send it out through a form of network, and reassemble the deconstructed information afterwards. In 1969, the four nodes of UCLA, Stanford University, UC Santa Barbara, and the University of Utah were successfully networked through ARPANet. Human society has since entered the network era, laying the foundation for the infrastructure of the digital economy. In the 1970s, cables to support the Internet began to be laid globally, connecting the world and forming a physics infrastructure to support the digital economy. The emergence of the Internet can be traced back as far as the ARPAnet established by the US Department of Defense in 1969, and over the course of its subsequent development, backbone networks, such as the NSFnet (1986) and the World Wide Web (1989), were gradually formed. During the development of the Internet, a number of historical milestones occurred, such as the birth of the e-mail "@", the development of the Transmission Control Protocol (TCP), and the first registered domain name, Symbolics.com" wave, as well as the impact of Microsoft Windows and the formation of the Hyper Text Transfer Protocol (HTTP) rules in 1989.

From the 1970s to the 1980s, the development of the Internet surged forward. 1977 saw the founding of Oracle Corporation and the development of a commercial SQL database. Japanese companies also began to enter the IT field, with NEC, Sharp, and Toshiba using memory as an entry point to achieve rapid growth in the field of semiconductor chips. Toshiba also designed the world's first laptop computer, and NEC and Fujitsu exported supercomputers to the world. In the field of mobile communication, mobile communication technology began to develop rapidly after the 1970s, and Qualcomm was established in 1985 to rapidly transform the original military communication technology, CDMA, into civilian use.

From the mid-1990s to the beginning of the new century, the network economy developed rapidly, along with the development of personal computers and network technology. In 1993, the US Clinton administration launched the "Information Superhighway" strategy, vigorously promoting the construction of information infrastructure, marking the entry of computer networks into the information superhighway development stage. In 1990, Archie was the first Internet search engine. In 1994, Netscape was established and developed the Navigator browser, and the market value of the stock reached billions of dollars on the first day of listing, which triggered the explosive growth of the IT industry, with the Internet as the core of IT. As the core of the Internet, IT began to penetrate all aspects of society and economics. In the search service, Yahoo and Google were established in 1995 and 1998, respectively. In the field of e-commerce, Amazon and eBay were founded in 1995 to challenge traditional commerce, and Netflix was established in 1997 to expand online movie rentals. Further, CISCO, 3COM, and BNC, the three major suppliers in the network hardware field, became the main beneficiaries, with revenues reaching US$1 billion. In China, Internet companies such as Tencent (1998), Alibaba (1999), and Baidu (2000) also started to take off. Since then, the digital economy has ceased to evolve non-consciously, and these emerging economic entities' platforms have become leaders and started to dominate the process of the digital economy explosion.

The boom in the development of the network economy reached its peak in 2000, as the speed of computing, storage size, and network speed of personal computers increasingly became the shackles of emerging economic development, making many business models that can be widely used today without effective technical support, and the development of the network economy far outpaced the development needs of the real economy, eventually leading to the bursting of the network economy bubble in 2000. In the 7th year after the burst of the Internet bubble in 2000, the subprime mortgage crisis (2007) broke out in the US, and the following year in 2008, a global financial crisis broke out that not only affected traditional economic sectors, but also involved the emerging digital economy. The impact of this crisis has been profound and long-lasting.

C. The second singularity of the digital economy explosion (2008–2014)

Under Moore's Law, with the geometric growth of computing speed, storage scale, and network speed of personal computers, the continuous progress of mobile communication technology, and the emergence of smartphones, the once-broken network economy ushered in another wave of prosperity driven by the new technology represented by mobile Internet and entered the mobile Internet era from PC Internet. In the field of mobile communication, mobile communication technologies, such as 3G and 4G, have gradually been put into use. In the mobile aspect, Apple launched the iPhone smartphone in 2007 and released the IOS operating system the following year. Samsung and other companies quickly followed, overturning the position of traditional cell phone manufacturers represented by Nokia and Motorola. In terms of Internet enterprises, new digital economic entities represented by social networking platforms have taken the stage of history, and Internet 1.0 companies represented by Yahoo are gradually replaced by Internet 2.0 companies, such as Alipay (2003), Facebook (2004), YouTube (2004), Twitter (2006), and WeChat (2013). Airbnb (2008), Uber (2009), and other sharing economy models began to lead the way. Among these, the Uber model has obvious innovative features (Fig. 2). In terms of the new generation of IT, cloud computing was officially introduced in 2006, and it has become a trend in the IT field. Satoshi Nakamoto's paper[5] soon spawned the first blockchain and the first bitcoin. His paper on Bitcoin triggered another type of sustained explosion in the digital economy that changed the perceived inertia of wealth. In this sense, the two Big Bang "singularities" are strikingly similar: both came from a single idea, both took the form of published papers, and both had negligible weight in material form.

When Bitcoin was first traded, 400 bitcoins were exchanged for $1 (equivalent to $0.0025, or RMB 0.17, for one bitcoin). The price of bitcoin has had its ups and downs, but today it is in the tens of thousands of dollars. On November 8, 2021, the highest price of bitcoin was $67,556: as of January 1, 2022, the price was $47,137 (down 30.22%), and the market cap was $887.92 billion (down 29.52%). Bitcoin originated with an idea, an article, and a development process that was much shorter in time and exploded with a much larger equivalent than the dramatic changes in the digital economy triggered by Leonard Kleinrock's paper in 1961 and the changes triggered by Satoshi Nakamoto's Bitcoin article. In 2013–2014, the second big change in the digital economy sparked by Satoshi Nakamoto's article was by a 20-something Vitalik Buterin, who brought about the birth of Ether (Ethereum) (Buterin, 2014). Ethereum became an open source and public blockchain platform with smart contracts, or the next generation of cryptocurrencies and decentralized applications. In 2014, Ether 1CO was successfully crowdfunded, and Ether became the second largest cryptocurrency. The highest price of Ether occurred on November 8, 2021, with a price of $4,812, and a market cap of $569.09 billion. As of January 1, 2022, the price of Ether was $3,700.34, with a market cap of $440.5 billion.

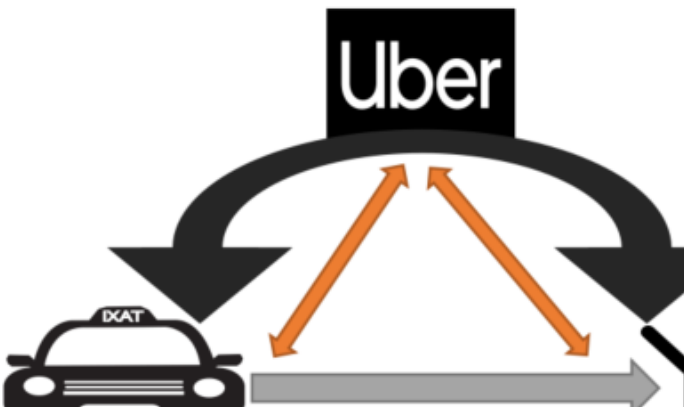

Figure 2. Uber Operating Mode

Source: compiled by the authors

[5] Nakamoto, S. Bitcoin. Available at: https://bitcoin.org/bitcoin.pdf

Buterin's creation of Ether is a big event in the history of crypto-digital currencies since 2008, which constituted the scale and stimulated the expansion of the blockchain application atmosphere. Due to Bitcoin and Ether, the number of crypto-digital currencies worldwide has exploded, and the digital economy driven by blockchains has become more vibrant. Digital currencies have continued to heat up in recent years, with Bitcoin currently having the highest market capitalization at over $700 billion, and the combined market capitalization of the top 15 cryptocurrencies ranked as of January 1, 2022 is over 1.2 trillion dollars. If we use the world's GDP as a reference, the total market capitalization of cryptocurrencies will be more than $2,244.1 billion as of January 2022, according to CoinMarketcap. This figure is close to the GDP of Switzerland in 2020 and exceeds that of Turkey and Saudi Arabia. There are no more than 20 countries in the world, with a GDP of more than $800 billion. Compared to the total market cap of $191.542 billion at the beginning of 2019, the entire digital currency market is up by $2052.56 billion, an increase of about 11 times year over year. The birth and development of digital currencies are inextricably linked to blockchain ideas and technologies, and the development of digital currencies has strong and constantly improving technical support, the core technology of which is the blockchain. The book "Blockchain Economics: Implications of Distributed Ledgers-Markets, Communications Networks, and Algorithmic Reality" by Melanie Swan (2016) and five other American scholars explains the new economic models that have emerged in the field of blockchain economics with the implementation of blockchain technology through distributed ledger technology (Long and Ascent, 2020).

The current acceptance of cryptographic digital currencies varies from country to country, but many countries are enthusiastic about the underlying blockchain technology that reduces social costs, improves social efficiency, and enhances the transparency of transactions. Cryptographic digital currencies are still one of the most popular blockchain applications, and the cryptocurrency industry chain is mainly focused on hardware manufacturers and trading platforms. There is still a long way to go in terms of popularization among the general public, but the rapid development of cryptographic digital currencies has driven the rapid development of the digital economy industry.

D. Digital economy in transition (2014–Present)

Since the first digital economy "singularity" in the 1960s, and the second digital economy "singularity" triggered by the birth of Bitcoin in 2008, there has been and is a "superposition effect", leading to a new digital economy explosion. We are now at the junction of the two "singularities". In terms of the history of the digital economy, "Singularity 1" is the digital economy trend that emerged from the 1960s–2010s based on the ICT industrial revolution, with the curve declining around the year 2000. "Singularity 2" is the new journey of the digital economy that originated from the Bitcoin blockchain. When the two curves intersect, why they intersect, and what the characteristics of the intersection are inconclusive for now, but the digital economy has reached a point in its history where it has developed new financial and monetary instruments to transform the capital model on its own (Fig. 3). In recent years, the digital economy has begun to form to reach a complete industrial chain and value, and the transformation to a new economic form, the intersection point, may arrive in the near future. The digital economy is now in the middle of a superposition process of two types of digital economy explosion, and continues to generate enormous energy, and it is certain that the superposition effect contributes significantly to the GDP, so that all countries benefit from it.

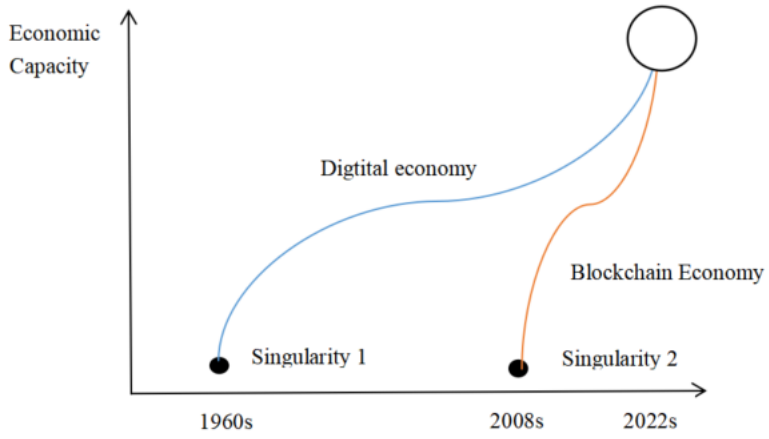

Figure 3. Digital Economy Explosion

Source: compiled by the authors

In 2016, the technological foundation of the digital economy came to a critical point in time, and a new digital economy change was quite brewing (Aitken, 2016). The key foundation of IT—microelectronics technology with integrated circuits as the core—will enter the 7 nm level from the current stage of 14 nm, and the manufacturing process is constantly approaching the physical limit. The traditional Moore's Law that will also come to an end, the digital economy will develop toward the IoT, cloud computing, big data, the IoT, AI intelligence, and so on. From the International Telecommunication Union (ITU) established in 2005 to formally putting forward the concept of the IoT after 15 years of cultivation and exploration, the global IoT is moving from the initial stage of fragmentation, isolated application-oriented into a new stage of focus, cross-border integration, and integrated innovation.

After the accumulation of technology in the early stages, cloud computing has entered a comprehensive explosion stage since 2016. According to Cisco's statistics, global cloud data center traffic will reach 19.5 ZB per year in 2021, cloud data center traffic will account for 95% of total data center traffic, compared with 88% in 2016, and the number of IoT connections will reach 13.7 billion, up from 5.8 billion in 2016 (Swan, 2017). Cloud service applications have penetrated all industries and become an important force for digital transformation in many industries. Big data is now widely used by governments and enterprises in decision-making, transportation, logistics, finance, advertising, telecommunications, healthcare, entertainment, and agriculture. According to the Cisco 2020 Internet Report, 5G will support more than 10% of the world's mobile connections by 2023, more than 70% of the world's population (5.7 billion people) will have a mobile connection (2G, 3G, 4G, or 5G), and 66% of the world's population (5.3 billion people) will be Internet users. With continued growth in mobile applications driven by social networking, video streaming and downloading, enterprise productivity, e-commerce, and gaming, the number of downloads will approach 300 billion by 20236.

According to IDC estimates this year, global Big Data market spending will reach approximately $298.3 billion by 2024, achieving a compound growth rate (CAGR) of approximately 10.4% from 2020-2024 (over 5 years). Meanwhile, China's big data spending as a whole is growing steadily, and the total market is expected to exceed $20 billion in 2024, an increase of 145% compared to 2019. The CAGR of China's big data market over the next five years is about 19.7%, leading the world in growth7. Nowadays, the digital economy has constituted a new ecosystem, from ICT to the knowledge industry, finance, and insurance, retail, all the way to the traditional processing industry, and the healthcare industry can see the length and future trend of the impact of digitalization on it. Now, any enterprise urgently needs to realize the transformation of digitalization or "algorithm", otherwise, it will not be able to coordinate

[6] New Cisco Annual Internet Report Forecasts 5G to Support More Than 10% of Global Mobile Connections by 2023. Available at: https://newsroom.cisco.com/press-release-content?type=webcontent&articleId=2055169

big data processing, the intervention of AI intelligence, and the embedding of blockchain, which will eventually ensure that enterprises can survive in the space and time dimension of the growing digital economy.

4. Results

4.1 Structural characteristics and development rules of the digital economy

A. Influence of Moore's law and Metcalfe's law

Two laws are often mentioned in the structural development of the digital economy: Moore's law and Metcalfe's law. Moore's law was proposed by Gordon Moore, one of the founders of Intel, in 1965 and originally described that the number of components that an integrated circuit can hold doubles approximately every 18-24 months with a doubling of performance at a constant price7. Moore's law reveals the speed of IT's progress (Keyes, 2006).

Metcalfe's law was introduced by George Gilder in 1993 but named after the last name of Robert Metcalfe, a computer networking pioneer and founder of 3Com, to honor and recognize his contributions to Ethernet. Its core is that the value of a network is equal to the square of the number of network nodes, and the value of a network is proportional to the square of the number of connected users. Metcalfe's law reveals the rule that the value of the Internet grows arithmetically or quadratically as the number of users grows. According to Metcalfe's law, the more users a network has, the greater the value of the entire network and each computer within that network—that is, the value of the network $V = K \times N2$ (K is the value factor and N is the number of users). The Internet has been growing exponentially since 1990, and its explosive penetration and expansion into all spheres of the economy and society have confirmed this law.

B. The wide application of ICT technology

Under the effect of Moore's law, the relative price of ICT products continues to fall, and investment in ICT continues to increase, making ICT a new driving force for economic development by largely replacing other factors of production, such as labor and capital. In the traditional manufacturing industry, industrial robots, AI, big data, and other information technologies are being used on a large scale. While reducing the demand for general labor and greatly improving production efficiency, ICT can simultaneously optimize the ability to transmit, process, and store information, thus enhancing the level of informatization of social life and industrial production. Since economic growth efficiency is generally expressed through total factor productivity (TFP), the study of ICT and economic growth efficiency is transformed into a study of the relationship between ICT and TFP. Based on the results of the analysis of 10 countries in Southeast Asia, we found that ICT contributes to the improvement of TFP, which means that ICT can improve economic growth efficiency.

There are two main paths for ICT to enhance economic growth efficiency: first, ICT is used to build an informatization network; the more network users there are, the greater the value of the informatization network, the greater the role of ICT for informatization spillover and diffusion, and the greater the role of ICT capital in contributing to TFP through network effects, thus enhancing economic growth efficiency; second, ICT can play a great role in enhancing the synergy among various elements in the production process of enterprises, solving the problem of information asymmetry, improving the efficiency of the IT production sector, which also has a positive effect on the IT using sector, and the TFP of each sector is improved, and the efficiency of economic growth is also improved.

C. Innovation by emerging technologies and talent-intensive output

The digital economy is a technology- and talent-intensive sector with the strongest innovation dynamics and the most pronounced boost to TFP, and it is often the main driver of economic recovery

[7] China Internet Network Information Center. Available at: https://www.cnnic.com.cn/

in economic downcycles. Innovative companies in the digital economy influence the economic environment under a crisis shock from two aspects: on the one hand, they can provide support and cushion the overall downward economy; on the other hand, in the economic recovery phase, innovative companies will rise rapidly and grow to lead the industry and even the whole economy as an engine with the advantages of technology and experience, while continuously exporting positive externalities to the economy. In the late 1970s, the world economy fell into a trough, affecting many developed countries. In this context, some economies took a different approach to revive the economy, no longer relying on traditional industries. Instead, they took the lead in supporting the country through the crisis by developing the digital economy, making it the leader in leading the economy out of the gloom. The regions of Emilia and Tuscany in central and northeastern Italy ("Third Italy"), Baden-Württemberg in Germany, Auyenax in France, Jutland in Denmark, Smyrna in Sweden, Barcelona in Spain, and Silicon Valley in the southern part of San Francisco in the US are all typical cases of new economy-led economic recovery. The 2019 PCT (patent cooperation treaty) application data released by the World Intellectual Property Organization show that computer technology and digital communications ranked in the top two of all technology areas, with digital economy-related companies occupying six of the top ten seats.

D. The digital economy has changed the industrial structure

Through the development of the digital economy, it can be found that the development of the digital economy has the following five major rules: it has risen from a mere industrial issue to a development question in terms of status. The digital economy is a new form of economic and social development following agricultural and industrial economies. It has upgraded and reshaped human society from multiple dimensions. In terms of production factors, with the advancement of new generation information and communication technologies, such as big data and artificial intelligence, data has become an important production factor in the new round of industrial competition, surpassing land and labor in agricultural civilization. Among the machines and equipment in the first industrial revolution and the capital in the second industrial revolution, whoever has information and data can take the lead in the digital era. In the construction of infrastructure, information and communication technologies are less costly and more efficient than traditional transportation infrastructures, such as railroads and highways, and will play a more important role in modern society, where the digital economy is increasingly critical. This is because of the borderless nature of the Internet. Therefore, in the era of the digital economy, the Internet closely connects all countries, and no country can be excluded from the wave of informatization. In the field of social life, the new generation of communication technologies has changed people's office and social habits, and the work and life patterns of the digital age are gradually being built up.

Technology and the market become the twin core drive of digital economy development, in which technology is the basic driving force to provide technical source assurance for the development of the digital economy, while the market application feedback makes the digital economy bigger and stronger. Take virtual reality (VR) as an example. As early as 1965 in the US, Ivan Sutherland's presentation during the IFIP conference entitled "The Ultimate Display" was an ultimate display of this concept. However, due to the lack of hardware capacity, algorithm defects, and other technical reasons of the 1980s, the development of VR technology was slow until the late 1980s, when the rapid development of information processing technology contributed to the progress of VR technology. After IT was invented and created, it was only with the impetus of the market that it could acquire a faster pace of development. For example, the Internet was first developed by the US military and began to be used in the military field in 1969, not open to the market. In 1980, the US began to popularize the Internet in academic institutions, and in 1989, commercial Internet service providers were established. In 1995, the Internet was fully commercialized in the US, bringing huge economic benefits to US enterprises.

Talent and data are the core elements of digital economy development, among which talent with high digital literacy is the most important resource in future digital economy development, while data is the main business kernel of today's society and future digital economy development. In the digital economy, especially in asset-light Internet enterprises with high technology content and data, highly skilled

talents are the core competitiveness of enterprise development. Further, data resources have the endowment of being analyzable, shareable, infinite growth and supply, breaking the constraints of a limited supply of traditional natural resources on growth and becoming a key production factor and an important resource for the development of the digital economy. With the progress and gradual popularization of IoT and Internet technologies, data interfaces are growing geometrically, and data storage technologies and data security precautions are constantly upgraded, making data an important strategic resource for individuals and enterprises and a core element of the digital economy. Data from the Internet Data Center (IDC) shows that the world created about 64 ZB of data in 2020, and by 2025, the global total data will reach 163 ZB, of which enterprises will account for 60%.

Close cooperation between industry and research is an important foundation for the development of the digital economy. Looking at the development history of the digital economy, we find that digital technologies often start with military needs and spread to the civilian sector after mature applications in the military field. From historical experience, once the high-quality innovative resources and technologies that have long been accumulated in strategic national security science and technology fields are accelerated and shared with the civilian sector and combined with market demand, they will stimulate endless innovative vitality and give rise to a large number of new technologies, products, and industries. For example, the US—from the "Manhattan Project" and the "Apollo Project" to the "Star Wars Project"—has attached great importance to the cooperation between government and enterprises on the pulling effect of science and technology innovation on industrial upgrading. The role of basic research is organically linked to overall national goals. This makes it the key to the development of the digital economy, with computers, the Internet, wireless communications, data security and recovery, and wireless video transmission as typical representatives.

Emerging small- and medium-sized high-tech enterprises are more innovative and dynamic. Small and medium-sized enterprises with flat organizational structures and management are more likely to develop into leading enterprises in an emerging field and lead the development of the industry to which they belong in the future for a period of time. In Europe and the US, for example, in each window of the digital technology revolution, a number of emerging IT companies emerged and formed a corresponding leadership position.

4.2 Measuring the digital economy

In the post-epidemic era, the digital economy is taking the development of human society into a whole new world. New approaches to leapfrogging are being developed, and new industries and economic models are emerging. The post-epidemic digital economy is rapidly evolving across sectors and industries, breaking down geographic constraints and becoming highly cross-cutting. This makes it impossible for governments and international organizations around the world today to fully measure the scale of digital economy development, and the construction of a digital economy development index is critical for understanding the current status and trends of the global digital economy. The digital economy is changing global economic activities through various forms of penetration, and also bringing new elements and ideas to various fields.

Measurement of major digital economy countries

As the digital economy continues to evolve, the European Union, the US Department of Commerce, the International Telecommunication Union, the World Economic Forum, the OECD, and the China Academy of Information and Communications Technology have all proposed building their own measurement standards and systems. For example, the OECD released "Measuring the Digital Economy a New Perspective". The Digital Economy and Society Index (DESI) was published by the European Commission, the Networked Readiness Index (NRI) was published by the WEF, the ICT Development Index (IDI) was published by the International Telecommunication Union (ITU), and the Digital Economy Index (DEI) was constructed by the China Academy of Information and Communication Research.

Table 3. Major Digital Economy National Measurement Standards

Country or region	Institution	Name of measurement system	Method of use	Date of publication
OECD Member	OECD	ICT Digital Economy Statistical Indicator System	Index Development Methodology	2014-2021
EU countries	European Commission	DESI		2014—2021
130 Economies	WEF	NRI		2002—2021
ITU Member States	ITU	ICT Development Index		1995—2017
CHINA		Digital industrialization, digitalization of industry Infrastructure	Infrastructure and fee-based digital services	2017—2021
US	Bureau of Economic Analysis	Infrastructure and fee-based digital services		2016—2021

Source: compiled by the author.

There is wide variation among countries and institutions in terms of measurement methods, regional scope, indicator content, and measurement results. The literature analysis shows that the digital economy measurement methods mainly focus on the indexing method and the value-added measurement method. At present, the digital economy is a concept of economic form, named after the outstanding features of that period. Although the conceptual content of the digital economy will continue to change with the expansion of the scope of the digital economy, measurement, and accounting indices have not yet formed a unified standard. As a result, the statistical results vary greatly. However, governments and international organizations are increasingly paying attention to the identification of the elements of the digital economy, and the concept of the connotation is becoming increasingly clear.

5. Discussion

The digital economy is growing and changing rapidly due to pandemic factors, and according to the United Nations Human Development Index and China (CAICT), the digital economy in developed countries is $24.4 trillion, or 74.4 percent of the global total. This is three times larger than the digital economy of developing countries. The digital economy in developed countries accounts for 54.3% of the GDP, far exceeding the 27.6% level of developing countries. Most people enjoy the "digital benefits" of digital technology, which improve efficiency and reduce the cost of time. However, due to different levels of economic development and geographical differences, the development of the digital economy has even increased digital inequality. There is consensus on how to narrow the digital divide, reduce digital inequality, and improve the digital literacy (digital skills) of the digitally "disadvantaged". To improve digital literacy, governments need to continue to increase the pace of digital transformation, strengthen digital governance, and end the digital "disadvantage" by reducing income inequality caused by the digital divide through proactive or reactive education and skills training. This will help people enjoy the dividends of the digital economy in economic development and achieve common prosperity.

6. Conclusion

With the rapid development of the global digital economy, it has become a key factor in reshaping the economic model and structure. This new form of economic form of digital economy requires more

cooperation among countries to make a good definition of the concept of digital economy and strengthen the depth of research on major issues, such as the impact of digital platforms, digital quality of life, digital divide, and other aspects of the economy and society. A clear grasp of the connotations of the digital economy and statistical accounting are issues that need to be focused on. One suggestion for promoting the high-quality development of the digital economy is to first promote the establishment of a standard, scientific, top-level measurement system. This can be done by strengthening theoretical research on the digital economy, exploring the measurement of the digital economy on the basis of a clear definition and extension, and taking the initiative to study and learn from the measurement methods. Second, there is a need to strengthen the operation and accounting testing of the digital economy. Third, we innovate data acquisition and processing methods. The upgrading of big data technology must be accelerated while establishing a training mechanism for data analysts and improving the efficiency of data acquisition and processing. Finally, we must accelerate the training of young people's digital literacy and digital capabilities. With the popularity and popularity of smartphones and social networks, the role of digital tools and media is becoming increasingly important, and people are demanding higher participation and sharing in work, learning, and life in a digital society. The empowerment of the digital economy allows disadvantaged groups in the model to be very lightly empowered by technology and to become a force for sustainable development in global regions. There is evidence in the UK that CTTI 4.0 has a positive impact on financial performance, and companies with good ESG tend to be more engaged in the digital economy. The digital economy is closely related to ESG, carbon neutrality, big data, and the green economy and has also become an important manifestation of sustainable social development (Alkaraan et al., 2022). The digital divide caused by the uneven spatial distribution of digital technologies has become a major factor in the creation of the digital disadvantaged, but the characteristic of the digital economy is that its various developmental stages can be crossed, and the maturity of ICT technology makes it possible for digitally backward countries to leapfrog the digital stage and reach the networked stage directly by connecting to the global network. This feature greatly reduces the cost of digital leapfrogging for digitally disadvantaged countries, and national governments have to formulate digital economy development strategies according to their own national digital economy development status, so as to realize the mission of the digital economy to change the future.

References

Aitken, R., 2016. Digital gold 'done right' with digixdao crypto-trading on openledger. Forbes.

Alkaraan, F., Albitar, K., Hussainey, K., Venkatesh, V. G., 2022. Corporate transformation toward Industry 4.0 and financial performance: The influence of environmental, social, and governance (ESG). Technological Forecasting and Social Change 175, 121423.

Bowman, J., 1996. The Digital Economy: Promise and Peril in the Age of Networked Intelligence. Academy of Management Perspectives 10(2), 69–71.

Buckley, P., Montes, S., Henry, D., Dalton, D., Gill, G., Dumagan, J., Shapiro, R., 2000. Digital economy 2000. Economics and Statistics Administration Office of Policy Development, Washington, DC: US Department of Commerce. Available at: http://www.esa.doc.gov/sites/default/files/de2kapp_0.pdf

Buterin, V., 2014. A next-generation smart contract and decentralized application platform. White Paper, 3 (37), 2–1.

Cassar, C., Heath, D., Micallef, L., 2020. What is digital economy? Unicorns, transformation and the internet of things. Deloitte Article.

Chohan, U., 2020. Some precepts of the digital economy. Productivity, Innovation & Technology eJournal. Social Science Research Network (SSRN), January.

Dresang, E. T., 1999. Radical Change: Books for Youth in a Digital Age. New York: HW Wilson Company. ISBN 0-679-76290-6.

Gospodarik, C.G., Kovalev, M.M., 2020. Belarus' v EAES: problemy i perspektivy ekonomicheskogo rosta [Belarus in the EAEU: Problems and perspectives of economic growth]. Journal of the Belarusian State University. Economy 1, 86–95

Henry, D.K., Buckley, P., Gill, G., Cooke, S., Dumagan, J., Pastore, D., 1999. The Emerging Digital Economy II. Washington, DC: US Department of Commerce. Available at: https://www.commerce.gov/sites/default/files/migrated/reports/ede2report_0.pdf

Heping, G., Fuxiang, W., 2021. Digital economy enables high-quality economic development: theoretical mechanism and empirical evidence. Nanjing Social Sciences (01), 24–33.

Jiang, Q., 2022. On value ontology of digital economy. Journal of Dongbei University of Finance and Economics. ISSN 1008-4096, CN 21-1414/F.

Jing, W.J., Sun, B.W., 2019. Digital economy promotes high-quality economic development: A theoretical analysis framework. Economist, 2, 66–73.

Keyes, R.W., 2006. The impact of Moore's Law. IEEE Solid-State Circuits Society Newsletter 11 (3), 25-27. https://www.doi.org/10.1109/N-SSC.2006.4785857

Li, K., Kim, D.J., Lang, K.R., Kauffman, R.J., Naldi, M., 2020. How should we understand the digital economy in Asia? Critical assessment and research agenda. Electronic Commerce Research and Applications 44, 101004.

Li, R., Gospodarik, C.G., 2022. The Impact of Digital Economy on Economic Growth Based on Pearson Correlation Test Analysis. In International Conference on Cognitive based Information Processing and Applications (CIPA 2021) (pp. 19-27). Singapore: Springer.

Long, A., Ascent, D., 2020. World Economic Outlook. International Monetary Fund.
Mansell, R., Steinmueller, W.E., 2013. Copyright infringement online: The case of the Digital Economy Act judicial review in the United Kingdom. New Media & Society 15 (8), 1312–1328.
Mesenbourg, T.L., 2001. Measuring electronic business: definitions，underlying concepts，and measurement plans. US Bureau of the Census.
Negroponte, N., 1999. Being Digital. New York: Knopf. ISBN 0-679-76290-6
OECD, 2014. The Digital Economy, New Business Models and Key Features. Addressing the Tax Challenges of the Digital Economy. OECD/G20 Base Erosion and Profit Shifting Project. Paris: OECD Publishing.
Pang, J., Zhu, X., 2013. The development trend of foreign digital economy and the national development strategy of digital economy. Scientific and Technological Progress and Countermeasures 30 (8), 124–128.
Rong, L., 2021. The future determines the present: A new era in the global future economy–digital economy. Available at: https://elib.bsu.by/handle/123456789/268050
Strassner, E. H., Nicholson, J.R., 2020. Measuring the digital economy in the United States. Statistical Journal of the IAOS 36 (3), 647–655.
Swan, M., 2017. Anticipating the economic benefits of blockchain. Technology Innovation Management Review 7 (10), 6–13.
Tapscott, D. 1996) The Digital Economy: Promise and Peril in the Age of Networked Intelligence. New York: McGraw Hill.
Woodward, R., 2009. The Organization for Economic Co-operation and Development (OECD). Routledge. Available at: http://www.oecd.org/daf/competition/The-Digital-Economy-2012.pdf
Xuguang, S., Zongyue H., 2016. Quantitative characteristics of China's long-range economic development. Journal of Beijing Normal University (Social Sciences) 2016.05.
Yu, C., 2021. Industrial policy and technological innovation of China's digital economy industry. Statistical Research 38 (1), 51–64.
Zhang, W., Zhao, S., Wan, X., Yao, Y., 2021. Study on the effect of digital economy on high-quality economic development in China. PloS One 16 (9), e0257365.
Zhao, Y., Wang, Z., 2003. Discussion on digital economy and digital economy era. Journal of Guangxi University for Nationalities: Philosophy and Social Science Edition (S1), 113–114.
Zhou, X., Zhou, D., Zhao, Z., Wang, Q., 2022. A framework to analyze carbon impacts of digital economy: The case of China. Sustainable Production and Consumption 31, 357–369.

Список источников

Aitken, R., 2016. Digital gold 'done right' with digixdao crypto-trading on openledger. Forbes.
Alkaraan, F., Albitar, K., Hussainey, K., Venkatesh, V. G., 2022. Corporate transformation toward Industry 4.0 and financial performance: The influence of environmental, social, and governance (ESG). Technological Forecasting and Social Change 175, 121423.
Bowman, J., 1996. The Digital Economy: Promise and Peril in the Age of Networked Intelligence. Academy of Management Perspectives 10(2), 69–71.
Buckley, P., Montes, S., Henry, D., Dalton, D., Gill, G., Dumagan, J., Shapiro, R., 2000. Digital economy 2000. Economics and Statistics Administration Office of Policy Development, Washington, DC: US Department of Commerce. Available at: http://www.esa.doc.gov/sites/default/files/de2kapp_0.pdf
Buterin, V., 2014. A next-generation smart contract and decentralized application platform. White Paper, 3 (37), 2–1.
Cassar, C., Heath, D., Micallef, L., 2020. What is digital economy? Unicorns, transformation and the internet of things. Deloitte Article.
Chohan, U., 2020. Some precepts of the digital economy. Productivity, Innovation & Technology eJournal. Social Science Research Network (SSRN), January.
Dresang, E. T., 1999. Radical Change: Books for Youth in a Digital Age. New York: HW Wilson Company. ISBN 0-679-76290-6.
Henry, D.K., Buckley, P., Gill, G., Cooke, S., Dumagan, J., Pastore, D., 1999. The Emerging Digital Economy II. Washington, DC: US Department of Commerce. Available at: https://www.commerce.gov/sites/default/files/migrated/reports/ede2report_0.pdf
Heping, G., Fuxiang, W., 2021. Digital economy enables high-quality economic development: theoretical mechanism and empirical evidence. Nanjing Social Sciences (01), 24–33.
Jiang, Q., 2022. On value ontology of digital economy. Journal of Dongbei University of Finance and Economics. ISSN 1008-4096, CN 21-1414/F.
Jing, W.J., Sun, B.W., 2019. Digital economy promotes high-quality economic development: A theoretical analysis framework. Economist, 2, 66–73.
Keyes, R.W., 2006. The impact of Moore's Law. IEEE Solid-State Circuits Society Newsletter 11 (3), 25-27. https://www.doi.org/10.1109/N-SSC.2006.4785857
Li, K., Kim, D.J., Lang, K.R., Kauffman, R.J., Naldi, M., 2020. How should we understand the digital economy in Asia? Critical assessment and research agenda. Electronic Commerce Research and Applications 44, 101004.
Li, R., Gospodarik, C.G., 2022. The Impact of Digital Economy on Economic Growth Based on Pearson Correlation Test Analysis. In International Conference on Cognitive based Information Processing and Applications (CIPA 2021) (pp. 19-27). Singapore: Springer.
Long, A., Ascent, D., 2020. World Economic Outlook. International Monetary Fund.
Mansell, R., Steinmueller, W.E., 2013. Copyright infringement online: The case of the Digital Economy Act judicial review in the United Kingdom. New Media & Society 15 (8), 1312–1328.
Mesenbourg, T.L., 2001. Measuring electronic business: definitions，underlying concepts，and measurement plans. US Bureau of the Census.
Negroponte, N., 1999. Being Digital. New York: Knopf. ISBN 0-679-76290-6
OECD, 2014. The Digital Economy, New Business Models and Key Features. Addressing the Tax Challenges of the Digital Economy. OECD/G20 Base Erosion and Profit Shifting Project. Paris: OECD Publishing.
Pang, J., Zhu, X., 2013. The development trend of foreign digital economy and the national development strategy of digital economy. Scientific and Technological Progress and Countermeasures 30 (8), 124–128.
Rong, L., 2021. The future determines the present: A new era in the global future economy–digital economy. Available at: https://elib.bsu.by/handle/123456789/268050

Strassner, E. H., Nicholson, J.R., 2020. Measuring the digital economy in the United States. Statistical Journal of the IAOS 36 (3), 647–655.
Swan, M., 2017. Anticipating the economic benefits of blockchain. Technology Innovation Management Review 7 (10), 6–13.
Tapscott, D. 1996) The Digital Economy: Promise and Peril in the Age of Networked Intelligence. New York: McGraw Hill.
Woodward, R., 2009. The Organization for Economic Co-operation and Development (OECD). Routledge. Available at: http://www.oecd.org/daf/competition/The-Digital-Economy-2012.pdf
Xuguang, S., Zongyue H., 2016. Quantitative characteristics of China's long-range economic development. Journal of Beijing Normal University (Social Sciences) 2016.05.
Yu, C., 2021. Industrial policy and technological innovation of China's digital economy industry. Statistical Research 38 (1), 51–64.
Zhang, W., Zhao, S., Wan, X., Yao, Y., 2021. Study on the effect of digital economy on high-quality economic development in China. PloS One 16 (9), e0257365.
Zhao, Y., Wang, Z., 2003. Discussion on digital economy and digital economy era. Journal of Guangxi University for Nationalities: Philosophy and Social Science Edition (S1), 113–114.
Zhou, X., Zhou, D., Zhao, Z., Wang, Q., 2022. A framework to analyze carbon impacts of digital economy: The case of China. Sustainable Production and Consumption 31, 357–369.
Господарик, Е.Г., Ковалев, М.М., 2020. Беларусь в ЕАЭС: проблемы и перспективы экономического роста. Журнал Белорусского государственного университета. Экономика 1, 86–95.

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