A Research on The Relationship Between Digital Economy and Sustainable Development of Regional Economy
——Based on Panel Data of Western Provinces

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Abstract: The digital economy based on information technology has had a huge impact on the fields of production, life and ecology, and has become an important way of economic sustainable development. This paper uses the provincial panel data from 2015 to 2020 in the west, and adopts the entropy weight method to construct an indicator system for economic sustainable development. Through the calculation of the coupling degree between the economic sustainable development capacity of each province and the development capacity of the digital economy and the theoretical analysis between the two, it is found that the coupling and coordination degree of the digital economy and the sustainable economic development capacity has been continuously enhanced, and the digital economy can achieve sustainable economic development.

Keywords: digital economy; sustainable economic development; entropy weight TOPSIS; coupling coordination degree

1   Introduction

My country's economic development has entered a new normal, which requires improving quality and efficiency, transforming economic growth patterns and economic development momentum, and realizing innovation-driven high-quality and sustainable development. The new round of scientific and technological revolution and industrial revolution has brought people into the era of digital economy, and digitalization has entered the fields of production, life, and ecology. [3], has become a new driving force for economic development [6], a new engine to achieve high-quality and sustainable economic and social development, and has become an important economic sustainable development model.

2 Sustainability and the connotation of digital economy and their relationship

2.1 Connotation of sustainable development

Sustainable development emphasizes development and focuses on revealing the systematic nature of "development, coordination, and sustainability", reflecting the organic combination of "power, quality, and fairness". The coordination of development refers to the comprehensive and coordinated development of economy, society and ecology; the sustainability and fairness of development refer to the development that meets the needs of the present without jeopardizing the needs of future generations. Sustainable development encourages economic growth, emphasizing increasing social wealth through economic growth, improving the happiness and welfare of present and even future generations, and achieving harmonious economic and social development. However, it is also emphasized that economic development cannot be at the expense of resources and the environment. It is required to use resources in accordance with the requirements of sustainable development under the conditions of protecting the environment and limited resources, reducing environmental costs, and realizing the common development of economy and ecology.

2.2 Connotation of digital economy

The country's 14th Five-Year Digital Economy Development Plan defines the digital economy as the main economic form following the agricultural economy and the industrial economy. In 2016, the "G20 Digital Economy Development and Cooperation Initiative" defined the digital economy as the use of digital knowledge and information as key production factors, modern information networks as an important carrier, and the effective use of information and communication technologies as efficiency enhancement and A series of economic activities that are important driving forces for the optimization of economic structure. The China Academy of Information and Communications Technology proposed the "four modernizations framework" of the digital economy, namely digital industrialization, industrial digitization, digital governance and data value. Among them, industrial digitization and digital industrialization are the core content, and industrial digitization dominates [8].

3 Theoretical mechanism for the development of digital economy to enhance the ability of regional economic sustainable development

Through the use of digital technology, the digital economy can empower traditional elements, expand the production possibility frontier, accelerate industrial restructuring, and promote innovation, thereby enhancing the ability of sustainable economic development.

3.1 Digital economy, factor resource allocation and regional economic sustainability

Under the digital economy, various online platforms use massive data to break through the time and space constraints of information dissemination, achieve efficient matching of subjects and information, and cross-regional allocation of innovative elements. Constraints are eased. The

digital economy improves the sustainable development capacity of the regional economy by expanding the production possibility frontier, empowering traditional factors, promoting the development of regional innovation activities, and promoting the adjustment, optimization and upgrading of the industrial structure.

The digital economy expands the production possibility frontier: Resources are scarce, and my country's per capita resources are even more scarce. The use of digital technology reduces the asymmetry of the resource factor market, improves the transparency of the factor market, and promotes the cross-regional flow and rational and efficient allocation of resources. At the same time, the use of digital technology can improve the efficiency and precision of resource extraction, bring about the economical production of production factors, reduce the consumption of resources in production, improve the efficiency of resource utilization, and expand the production possibility frontier. Digital technology provides means for the sustainable development of the economy, promotes more efficient and economical economic development, and makes the economic structure more reasonable.

Digital economy empowers traditional elements: Labor supply and demand information is time-sensitive, and the development of the digital economy has weakened the asymmetry of labor market information, improved market transparency, and enhanced the convenience and timeliness of labor market information acquisition. Comprehensive, accurate and effective labor market information reduces the mismatch in the human capital market and improves the allocation efficiency of labor factors. Second, the development of the digital economy promotes the production of high-quality labor. The integration and development of the digital economy with traditional industries will have an impact on low-quality workers. In order to better match workers with jobs, enterprises will increase training for workers. Improve their skills and quality through training and other methods [1]. At the same time, in the process of upgrading and transforming traditional industries in the digital economy, emerging industries such as smart logistics and intelligent transportation continue to emerge, attracting a large number of high-quality human capital accumulation, promoting the generation of professional, compound and practical talents, and contributing to economic development. Provide high-quality human capital.

Digital technology can enable the main body of economic activities to obtain information on the supply and demand of funds in a timely and accurate manner, thereby improving the allocation efficiency of R&D capital and the speed of capital use. With the vigorous development of the digital economy, on the one hand, the emergence of economies of scale in industrial development can share production costs; on the other hand, the emergence of Internet finance and digital finance has effectively solved the difficulty of financing and loans for small and medium-sized enterprises and technology companies, and the lack of innovation funds. problems [5] [9], increase the innovation vitality of enterprises and improve the sustainable development level of the regional economy.

3.2 Digital economy promotes industrial restructuring and upgrading

Digital industrialization and industrial digitization are the main part of the digital economy. Digital industrialization refers to the process of digital technology forming an industry, which is the core industry of the digital economy. The process of digital industrialization is a process of technological innovation, industrial upgrading, and high-end industrial development, so it

will definitely enhance the sustainable development capacity of the regional economy. Industrial digitization is a digitally empowered industry, which is a process in which traditional industries use digital technology to transform and upgrade to achieve industry and efficiency improvement. On the one hand, the development of the digital economy has made the industry and the service industry penetrate each other, the real economy and the emerging service industry have been continuously integrated, and the boundaries between the three major industries have become increasingly blurred; and promote the transformation and upgrading of the industrial structure.

3.3 Digital economy enhances regional innovation capabilities

Innovation is an important driving force for sustainable development. Cheng Jianlin and Ai Chunling (2008) believe that technological innovation is at the core of sustainable development. [2] Zhao Chuansong and Ren Jianlan (2018) also believe that technological innovation plays an important role in sustainable development strategies and is an important foundation and key means for sustainable development. [11] Professor Jia Xiangtong (2020) believes that technological innovation and ecological development have a natural unity. [4] The digital economy improves the sustainable development of the regional economy by promoting the continuous generation of innovation. Behind the digital economy is actually the data economy. Without data, there is no economy. Data is the core engine of the deepening development of the digital economy, and its multiplier effect on production efficiency is constantly prominent. The full flow of data elements will effectively promote the role of logistics, people, and capital in regional economic development, and expand the depth of element release. As an advanced factor of production data, it can continuously empower primary factors of production, namely labor, capital and land, and reduce the mismatch of various factor resources through the continuous accumulation of data and the improvement of algorithm capabilities [10], and improve the efficiency of factor production. At the same time, the data itself has the characteristics of strong penetration, high correlation and high innovation, which can produce synergistic effects [7]. The use of data elements breaks the information silos between enterprises, governments, society and other departments, realizes cross-regional, cross-industry, cross-time and space information sharing, and effectively promotes the generation of collaborative innovation.

4 Empirical analysis of digital economy and economic sustainable development capability

4.1 Study area and data sources

The study area is 11 provinces (autonomous regions and municipalities directly under the Central Government) in the west (excluding Tibet), and the data comes from the National Bureau of Statistics, "China Statistical Yearbook" and other materials.

In order to reflect the sustainable development capacity of the western economy, on the basis of the principles of scientificity, completeness and feasibility of index construction, representative indicators are selected to construct the evaluation index of economic sustainable development capacity, as shown in Table 1. The indicator system starts from two aspects of economic development and economic governance, with a total of 6 elements. After standardizing the data, the entropy method is used to determine the weight.

Table 1. Economic Sustainable Development Measurement Index System

first dimension	secondary dimension	specific indicators	Attributes
economic development	The level of economic development	per capita	+
	economic diversification	value of the tertiary industry as a share of GDP	+
	LF	Electricity consumption per unit of GDP	-
State of Economic Governance		Industrial governance completed investment	+
	Environmental governance	Proportion of Environmental Protection Expenditure to Fiscal Expenditure	+
		Harmless treatment rate of domestic waste	+

4.2 Coupling coordination degree model

The coupled coordination degree model is used to analyze the coordinated development level of things. Coupling degree refers to the interaction between two or more systems to achieve the dynamic relationship of coordinated development, which can reflect the degree of interdependence and mutual restriction between systems. The degree of coordination refers to the degree of benign coupling in the coupling interaction relationship, which can reflect the quality of coordination. The model is as follows:

The first step is to establish a coupling model of economic sustainable development capability and digital economy development capability, and calculate the coupling degree C

$$C = \frac{2 \times \sqrt{U_1 \times U_2}}{U_1 + U_2}$$

(1)

U_1 is the score of economic sustainable development capability, and is the score U_2 of digital economy development capability, and the value range of coupling degree C is [0,1]

Step 2: Introduce the T value of the coordination indicator $T = aU_1 + bU_2$ $\quad a = b = 0.5$

Step 3: Calculate the coupling coordination degree D value: $D = \sqrt{C \times T}$, the value range of D is [0, 1].

4.3 Empirical Analysis Results

Use SPSSAU to calculate the weight of each indicator of economic sustainable development ability, and calculate the score of economic sustainable development ability. The results are shown in Table 2 and 3.

Table 2. Summary of weight calculation results by entropy method

item	Information entropy value e	Information utility value d	Weight coefficient w
GDP per capita	0.9381	0.0619	12.18%
Industrial structure	0.9585	0.0415	8.17%
Industrial governance completed investment	0.8954	0.1046	20.59%
Harmless treatment rate of domestic waste	0.9681	0.0319	6.27%
Proportion of Environmental Protection Expenditure to Fiscal Expenditure	0.9459	0.0541	10.65%
Electricity consumption per unit of GDP	0.7859	0.2141	42.14%

Table 3. Economic Sustainability Score

| province	2020	2019	2018	2017	2016	2015
Sichuan	0.820588	0.702904	0.685233	0.675999	0.614412	0.582065
Chongqing	0.731385	0.693392	0.764446	0.779228	0.737552	0.724864
Yunnan	0.655926	0.65783	0.58012	0.574881	0.593848	0.580993
Guizhou	0.620547	0.565707	0.532628	0.501443	0.473754	0.46787
Guangxi	0.498192	0.494076	0.541115	0.56115	0.576259	0.620789
Gansu	0.447605	0.448982	0.290384	0.472079	0.418608	0.415992
Qinghai	0.271757	0.299633	0.25762	0.273704	0.37908	0.309953
Shaanxi	0.778783	0.854485	0.699448	0.700278	0.674663	0.730338
Ningxia	0.278467	0.262004	0.305226	0.289674	0.319979	0.225637
Inner Mongolia	0.437404	0.578147	0.660572	0.682114	0.737437	0.767913
Xinjiang	0.269179	0.381817	0.390249	0.25336	0.261855	0.307221
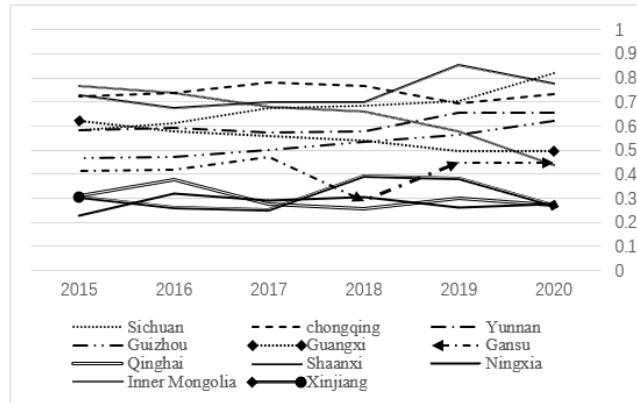
Fig. 1. The changing trend of economic sustainable development ability in 11 western provinces

It can be seen from the figure 1 that the economic sustainable development capacity of the four provinces of Ningxia, Xinjiang, Qinghai and Gansu continued to be lower than 0.5 during the period of 2015-2020 and the sustainable development capacity was low. Shaanxi, Chongqing and Sichuan have the top three all year round. The sustainable development capacity of Inner Mongolia and Guangxi continued to decline. The sustainable economic development capacity of Guizhou and Sichuan provinces continues to rise.

In the measurement of the digital economy development level, the digital development index of the western provinces of China's digital economy measurement results by Liu Jun, Yang Yuanjun, and Zhang Sanfeng is used.
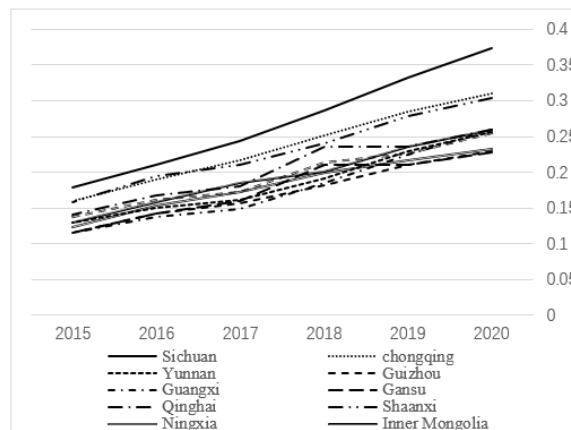

Fig. 2. The changing trend of digital economy development capacity in 11 western provinces

It can be seen from the figure 2 that the development level of the digital economy in each province is on the rise year by year, Sichuan has always been in the leading position, and Shaanxi has experienced a large increase in 2018.

Table 4. Scoring ranking and coupling coordination degree of two economic indicators in 11 western provinces

province	Economic Sustainability	Digital Economy Development Capability	Coupling coordination
Sichuan	1	1	1 0
Shaanxi	2	3	9
Chongqing	3	2	9
Yunnan	4	7	7
Guizhou	5	10	4
Guangxi	6	4	6
Gansu	7	11	3
Inner Mongolia	8	6	6
Ningxia	9	9	2
Qinghai	10	5	3
Xinjiang	11	8	3

From Table 4, it can be seen from the comparison of the rankings of the economic sustainable development capacity and digital economy development capacity of each province in 2020 that Sichuan, Shaanxi, and Chongqing are ranked in the top three in the two indicators, and their development is in a good coupling state. The digital economy development capabilities of Yunnan, Guizhou, and Gansu lag behind the sustainable development capabilities, and the digital economic development capabilities of Guangxi, Inner Mongolia, Qinghai, and Xinjiang are stronger than the sustainable development capabilities.

Table 5. Coupling and coordination levels of the two indicators in 11 western provinces in 2015 and 2020

Province	2015	2020
Sichuan	2	1 0
Chongqing	3	9
Yunnan	2	1 0
Guizhou	2	1 0
Guangxi	4	2
Gansu	3	1 0
Qinghai	3	6
Shaanxi	3	9
Ningxia	2	9
Inner Mongolia	4	4
Xinjiang	3	6

From the coupling coordination level of the sustainable development capacity and digital economy development capacity of the 11 western provinces in Table 5 in 2015 and 2020, it can be seen that, except for Guangxi and Inner Mongolia, the coupling and coordination of digital economy development capacity and economic sustainable development capacity in other provinces have improved. The digital economy continues to drive the sustainable development of the regional economy.

5 Conclusion

The digital economy has an enabling effect and a spatial spillover effect on regional economic development. On the whole, it can improve the level of regional economic development. The openness and borderless nature of the digital economy enables resource elements to break through the limitations of time and space, bridge the adverse effects of regional restrictions on innovation subjects and innovation resource elements on regional economic development, and realize a more rational allocation of resources. To improve the sustainable development capacity of the regional economy by promoting the development of regional innovation activities, promoting industrial structure adjustment, optimization and upgrading, etc.

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