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Study on the Identification of Obstacle Paths for Digital Economy Promotion in Underdeveloped Regions based on ISM-MICMAC Modeling

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Abstract. Identifying the obstacles in the path of barriers to the promotion of the digital economy in less-developed regions can provide insight into the underlying causes that lead to the limited development of the digital economy. This helps the government and related organizations to formulate targeted policies and measures, which can be targeted to address the different barriers in solving the digital economy promotion problems and improve the development of the digital economy. A total of 26 influencing factors of barriers to the promotion of digital economy from six dimensions are categorized into three levels: surface, middle, and bottom according to the ISM model, and the influencing factors are categorized into three clusters of influencing factors, namely, independent, autonomous and connected, using the MICMAC method. The results of the study show that: (1) the digital divide factors such as the lack of digital economy professionals and the relatively weak economic foundation are the underlying factors hindering the promotion of the digital economy, and have the deepest impact on the obstacles in the path of digital economy promotion. (2) Inadequate education system, lack of government funding, and lack of related policy support are the linkage factors in the path of barriers to the promotion of the digital economy, with greater dependence and driving force, which need to be focused on.

Keywords: Digital Economy; Diffusion Barrier Identification; Interpretative Structural Modeling; Cross-impact Matrix Multiplication.

1. Introduction

Under the development wave of the new round of industrial and technological revolutions, digital technologies such as big data and artificial intelligence have been widely applied, promoting the vigorous development of the digital economy. The digital economy has become a key factor in reconfiguring the international competition pattern, reshaping the global economic structure, optimizing the allocation of global factors and resources, and has gradually become a powerful engine for activating rural economic development. The organic combination of digital economy and rural revitalization has become an unavoidable trend and a new driving force for economic growth. Promoting the development of a digital economy-enabled agricultural industry is not only an inevitable requirement for the development of agricultural modernization, but also a core point of the layout of rural revitalization strategy.

Current scholarship on the rural digital economy focuses on several dimensions.

In terms of theoretical research, the transformation of the rural economy in the direction of high-quality development is an inevitable choice for the sustainable development of the economy, and the digital economy has become one of indispensable aids in the process of high-quality development of the rural economy. Through the innovation of the development mode of the rural economy, the digital economy weakens the barrier of urban-rural dual structure, stabilizes agricultural production, and promotes the sustainable development of rural areas, thus boosting the high-quality development of the rural economy.[1] The digital economy has been a major contributor to the development of the rural economy. However, in the process of promoting the development of the digital economy in rural

areas, it faces some outstanding problems, such as a lack of understanding of digital productivity, lagging in the construction of information technology infrastructure, and low digital literacy among farmers.[2]This has led to an inefficient digital transformation of rural agriculture. The root cause of rural digital poverty may be the insufficient participation of farmers in the digital social economy and their lack of digital knowledge, literacy skills[3] . At the same time, the integration and development of the rural digital economy with the rural economy also face bottlenecks in terms of constraints in digital infrastructure, data sharing systems, digital economy talent, relevant standards, and laws and regulations[4] The development of rural digital economy and rural economy is also facing bottlenecks in digital infrastructure, data sharing system, digital economy talents, relevant standards, and laws and regulations. Aiming at these real problems and constraints, some studies have also explored the future trends, development countermeasures, and breakthrough paths of the rural digital economy[5-6] .

In terms of empirical research, it mainly involves the effective measurement study of the role of the digital economy in promoting urban-rural integrated development, regional differences, evaluation methods, and other aspects. In the measurement study of the role of the digital economy in promoting urban-rural integrated development, the digital economy for rural revitalization is the main focus, and the spatial Durbin model is used[8],threshold analysis[9],mediating effect model[10] and coupling analysis[11] and other methods for quantitative research. Shu et al.[8] measured the spatial evolution characteristics of the digital economy by using methods such as the Gini coefficient and spatial autocorrelation analysis, and concluded by applying spatial econometric models that the development of the digital economy has a positive impact on the enhancement of the level of urban-rural integration. This positive impact is mainly dominated by the local effects of digital industrialization, industrial digitization, and digital innovation. Li et al.[9] come to a different conclusion, they believe that the digital economy has an "inverted U-shaped" impact on rural development, i.e., there is a threshold effect of the level of digital economy development on the urban-rural income gap. In terms of research on regional differences, Xu et al. [12] measured the value added of China's digital economy and total output from 2007 to 2017, and compared the results with those of the United States and Australia, concluding that the average annual real growth rate of China's value-added digital economy is significantly higher than that of developed regions such as the United States and Australia. At the same time, some scholars also focus on the eight domestic comprehensive economic zones[13] and Northeast China[5] and nine provinces in the Yellow River Basin[14] and other regions, and some scholars have also analyzed regional differences in the level of digital economy development. In terms of evaluation methods, He et al.[15] adopted the factor decomposition method and AHP method to construct the indicator evaluation system of China's green ecological efficiency and China's digital economy development respectively, and measured and analyzed the level of China's digital economy development, while Cheng et al. constructed the indicator evaluation system based on the input-output perspective.[16] on the other hand, constructed an indicator system based on the input-output perspective and used the EWM-TOPSIS model to comprehensively measure the digital economy input and output levels of China's provinces in 2018. On this basis, they also measured the digital economy input and output efficiency of China's provinces using DEA network analysis.

Previous studies have made a great deal of discussion on the barriers to the promotion of digital economy in less developed regions, and they have sorted out the main obstacle factors to the development of the digital economy in less developed regions, such as imperfect infrastructure and the digital divide, using a literature review or model measurement. Some studies have analyzed the gaps and reasons for the development of the digital economy in less developed regions by comparing the current status of digital economy development in different countries and regions. Some scholars have also measured the effect of the digital economy on the development of less developed regions through various methods, and provided empirical data and cases, which provide valuable experience for an in-depth understanding of the obstacles to the development of the digital economy in less developed regions and solving the urban-rural gap and other practical problems. However, considering that the previous studies have rarely explored the linkages and interactions among the

obstacles to the development of the digital economy, and have not used empirical analyses to test the hierarchical relationship between obstacles, this paper proposes a new approach to the development of digital economy in less developed regions. hierarchical relationship between the obstacle factors, therefore, this paper proposes an empirical method based on the ISM-MICMAC model to study the obstacles to the promotion of digital economy in underdeveloped regions.

2. Identification of Impediments to the Promotion of Digital Economy in Less Developed Regions

2.1. Infrastructure

Digital economy infrastructure refers to a series of infrastructures and technical systems that support the development of the digital economy. It includes a variety of digitized hardware equipment, software systems,network communication facilities, and related data resources and services.The presentation of digital economic infrastructure mainly includes communication networks,data centers,etc.,which transmit,store,calculate,and analyze digital information from different dimensions. At the core of infrastructure is digital technology that can be shared by multiple users, provide public services, and allow access to different applications and services. Infrastructure should be resilient and scalable,and it also needs to have security measures to protect user data and privacy.The construction and development of digital economy infrastructure are of great significance in promoting the development and innovation of the digital economy,which can improve economic efficiency,promote industrial upgrading,and drive innovation.

2.2. Digital Divide

The digital divide refers to the gap and inequality in digital capabilities and opportunities between different individuals, organizations, and regions due to the uneven diffusion and application of digital technologies. Less developed regions are unable to fully utilize digital technologies to access and use information due to a lack of knowledge and skills in digital technologies. Less developed are also unable to obtain stable network access and suitable digital equipment due to economic conditions, geographical remoteness, and inconvenience. The digital divide has led to gaps and inequalities in digital capabilities and opportunities among different individuals, organizations,and regions, exacerbating social and economic inequalities and preventing some groups of people from enjoying the opportunities and benefits of digitalization, while at the same time hampering regional development and innovation capabilities and restricting the overall development of the digital economy.Addressing the digital divide requires the concerted efforts of Governments,businesses,and all parties in society to adopt policies and measures to promote digital inclusion and equality.

2.3. Economic Environment

The economic environment refers to the various external conditions and factors that affect the operation and development of the economy. It includes political,legal,social,cultural,technological and other factors,as well as internal economic factors such as market structure,industrial development,and competitive conditions. In the context of the digital economy, many changes have taken place in China's economic environment. Digital technology is gradually becoming an important driving force for economic development, promoting changes in industrial structure and innovation in business models. Data has also become an important resource for economic activities,and the ability to acquire,process,and analyze data has a significant impact on the competitiveness of enterprises and organizations. The spread of digital technology and the development of the Internet have facilitated the integration and crossover between different industries and the formation of new industrial and value chains,which have allowed economic activities to transcend national boundaries and facilitated the process of globalization.

2.4. Cultural and Social Context

Cultural and social context refers to the common features in terms of values,beliefs,customs, traditions, and norms of behavior that are shared by a society or group. Cultural and social contexts affect people's consumption behaviors and preferences. People's demand for products and services, purchasing habits, and consumption attitudes will differ across cultures and social contexts, thus affecting market demand and consumption patterns in the digital economy. Cultural and social contexts can also have an impact on the innovation and entrepreneurship environment. Less developed regions have a lower risk tolerance for innovation and entrepreneurship, which can hinder innovation and entrepreneurial activities in the digital economy.In terms of social cognition and acceptance, less developed regions are mostly peasants,with low levels of education and Internet experience, and have low levels of cognition and acceptance of digital technologies, online platforms, and e-commerce,which affects the development and popularization of the digital economy.

2.5. Policy and Legal Environment

The policy and legal environment refers to the policy and legal frameworks developed and implemented by a country or region in the field of the digital economy. They aim to regulate and guide the development of the digital economy, protect the rights and interests of relevant stakeholders, and promote the healthy and sustainable development of the digital economy. The policy and legal environment can provide guidance and support for the development of the digital economy and promote its innovation and development. Fair policy regulations can protect the rights and interests of all stakeholders in the digital economy and maintain market order and fair competition. Policies and regulations related to the digital economy can regulate the behavior of the digital economy market, prevent unfair competition and unlawful behavior, further provide a referable framework and rules for international digital economy cooperation and exchange, and promote international digital economy cooperation and development.

2.6. Science, Technology, and Innovation

Economic environment STI refers to the creation of new products, services, or production methods through the introduction of new scientific knowledge, technologies, and methods, thereby contributing to social and economic development. STI is a creative activity aimed at solving real-world problems, increasing efficiency, and improving the quality of life. Science, technology, and innovation provide new technologies and tools to drive innovation and development in the digital economy. Industry innovation as well as innovation within enterprises can enhance the digital capabilities of enterprises and individuals, and promote the transformation and upgrading of the digital economy.In terms of future development, STI can promote the construction of the digital economy ecosystem,including technology research and development,business incubation,and investment and financing. Governments,enterprises,and individuals should actively participate in and promote STI for the healthy and sustainable development of the digital economy.

3. ISM-MICMAC Model Construction

3.1. ISM Method

ISM (Interpretive Structural Modeling) is a method of explaining the structural relationship of system influencing factors, which was put forward by Prof.Warfield of the United States in 1973.It originates from modern systems engineering analysis and is often used to analyze complex socio-economic problems at a deeper level. ISM can effectively reveal the intrinsic connection between the influencing factors,and help to find out the factors leading to the research problem [17].The ISM method collects real data,and uses the theoretical deductive approach to reveal the interrelationships of the influencing factors of a complex economic and social system and presents them in a multi-layer a hierarchical structure to show the internal structure of a complex system in a clearer, more rigorous and hierarchical way, and hierarchical way to show the internal structure of the complex

system in a more clear, strict and hierarchical way. [18] Theory and Deduction. The specific steps to build the model are as follows: STEP1:Determine the research topic and construct the set of influencing factors $S = \{S_1, S_2, \cdots, S_n\}$ .Based on whether there is a direct influence relationship between S_i and S_j ,determine the adjacency matrix between the influencing factors $A = (a_{ij})_{n \times n}$,which is defined as:

$$a_{ij} = \begin{cases} 0, S_i \text{ has a direct binary relationship with } S_j \\ 1, S_i \text{ has no direct binary relationship with } S_j \end{cases} \quad (1)$$

Table 1. Summary of indicators of barriers to the promotion of the digital economy

Level 1 indicators	Secondary indicators	Reference
Infrastructure	Incomplete infrastructure (S_1)	[3]
	Low level of rural IT adoption (S_2)	
	Inadequate supporting facilities (S_3)	
	Operational rigidity of web service platforms (S_4)	
	Less digital payments and financial infrastructure (S_5)	
Digital divide	Late start of digital information technology (S_6)	[4]
	Lack of digital skills among farmers (S_7)	
	Shortage of digital economy professionals (S_8)	
	Fragmentation of information and difficulties in data collection (S_9)	
	Weak economic and social base (S_{10})	
Economic environment	Inadequate support from financial institutions (S_{11})	[11]
	Unstructured socio-economic structure (S_{12})	
	Low market demand and consumption capacity (S_{13})	
	Small market size and demand (S_{14})	
	Social perception and acceptance (S_{15})	
Cultural and social factors	Low levels of digital literacy (S_{16})	[7]
	Lack of social capital and cooperative networks (S_{17})	
	Inadequate education system (S_{18})	
	Lack of social trust (S_{19})	
	Lack of government funding (S_{20})	
Policy and legal environment	Lack of relevant policy support (S_{21})	[13]
	Insufficient interaction between government departments (S_{22})	
	Rigid urban and rural planning (S_{23})	
	Relevant laws and regulations are still not perfect (S_{24})	
Science,technology,and innovation	Mismatch between production and demand for science and technology (S_{25})	[8]
	Lag in scientific and technological research and development (S_{26})	

STEP2:Calculate the adjacency matrix and generate the reachable matrix. According to the Boolean algorithm, with the help of SPSS software, the adjacency matrix A is added to the unit matrix I ,and the power operation is performed on it, if the matrix M satisfies the following conditions, the reachable

matrix $M = m_{ij}(n \times n)$ of the matrix A is obtained,which is calculated as follows: when $(A+I) \neq (A+I)^2 \neq (A+I)^3 \neq \cdots\cdots \neq (A+I)^k \neq (A+I)^{k+1}$,the reachable matrix $M = (A+I)^k$

STEP3:Divide the factor hierarchy and build the ISM model. Factor division can judge the hierarchical relationship between each other more clearly, which is conducive to constructing a scientific hierarchical model.According to the obtained reachable matrix M ,find the reachable set $R(S_i)$,the prior set $A(S_i)$,the intersection set $C(S_i)$. The formulas are shown in equations (2)-(4):

$$R(S_i) = \{S_x, S_x \in S, m_{ix} = 1, x = 1, 2, \cdots, n\} (i = 1, 2, \cdots, n) \tag{2}$$

$$A(S_i) = \{S_x, S_x \in S, m_{xi} = 1, x = 1, 2, \cdots, n\} (i = 1, 2, \cdots, n) \tag{3}$$

$$C(S_i) = \{S_x, S_x \in S, m_{ix} = 1, m_{ix} = 1, x = 1, 2, \cdots, n\} (i = 1, 2, \cdots, n) \tag{4}$$

3.2. Cross-influence Matrix Multiplication

The method of cross-influence matrix multiplication (MICMAC) is a cross-influence matrix multiplication method for classification,which was proposed by Duperrin and Godet in 1973.The MICMAC method can be used to identify highly driving and highly dependent variables in a system and analyze the hierarchy of different influences in the system and the degree of interaction. [18] The results of MICMAC are usually presented in a four-quadrant diagram of the driver-dependency matrix,where the horizontal coordinate represents the dependency,and the vertical coordinate represents the strength of the driver,and the distribution of the factors in the four quadrants represents the four clusters of influences: autonomy,dependency,linkage,and independence,which can be graphically analyzed to find the management and intervention priorities of the system.management and intervention priorities in the system can be found through graphical analysis.

The MICMAC method is used to analyze the influencing factors, deeply classify the status and role of the influencing factors,determine the corresponding dependence D_i and driving force R_i ,and put forward targeted countermeasure suggestions.The values of driving force and degree of dependence are calculated according to the following formula,where dependence refers to the number of elements that correspond to 1 in the columns of each factor in D_i ,and driving force refers to the number of elements that correspond to 1 in the rows of each factor in R_i .Larger values indicate a stronger degree.The error line of the mean value of drive and dependence is used as the quadrant division line to divide the axis into four parts, which are dependence cluster, independence cluster, autonomy cluster and linkage cluster. The influences in the reachability matrix were divided into the four quadrants of the drive-dependence obtained from the reachability matrix calculation.

$$D(a_{ij}) = \sum_{j=1}^{n} a_{ij} (i = 1, 2, \cdots, n) \tag{5}$$

$$R(a_{ij}) = \sum_{j=1}^{n} a_{ij} (i = 1, 2, \cdots, n) \tag{6}$$

4. Empirical Analysis

4.1. ISM Calculations and Analysis

This paper invites six experts and scholars who come from the related research fields of digital economy,corporate finance,corporate green investment,and corporate sustainable development.To ensure the scientificity and accuracy of the extraction of the influencing factors and reduce the impact on the results due to the subjective will of the experts,this paper firstly consults two experts with senior experience in the research of the digital economy and conducts a pre-survey on the extraction

of the influencing factors; secondly,it conducts anonymous scoring without communication,and finally obtains the scoring results as shown in Table 2:

Table 2. Neighborhood matrix

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}	S_{13}	S_{14}	S_{15}	S_{16}	S_{17}	S_{18}	S_{19}	S_{20}	S_{21}	S_{22}	S_{23}	S_{24}	S_{25}	S_{26}
S_1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
S_6	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
S_7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
S_9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{10}	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{11}	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{12}	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{13}	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{14}	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
S_{15}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
S_{16}	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{17}	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{18}	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
S_{19}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
S_{20}	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
S_{21}	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
S_{22}	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{23}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
S_{24}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
S_{25}	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{26}	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Based on the adjacency matrix,ISM model calculations were carried out in conjunction with SPSS data analysis software to obtain the reachability matrix,which reflects the direct and indirect relationships between the factors,as shown in Table 3.

According to the normalized reachability matrix,the obstacles hindering the promotion of the digital economy are divided into three levels,and then the influencing factors with correlations are further connected,and the relationships between the levels reflect their influence paths.The ISM model is constructed,as shown in Figure 1.

Table 3. Reachability matrix

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}	S_{13}	S_{14}	S_{15}	S_{16}	S_{17}	S_{18}	S_{19}	S_{20}	S_{21}	S_{22}	S_{23}	S_{24}	S_{25}	S_{26}
S_1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_3	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_4	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_5	1	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
S_6	1	1	1	1	0	1	1	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	0
S_7	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_8	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1
S_9	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{10}	1	1	1	1	0	1	1	0	1	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0
S_{11}	1	0	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{12}	1	1	1	1	0	1	1	0	1	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0
S_{13}	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
S_{14}	1	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
S_{15}	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
S_{16}	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
S_{17}	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
S_{18}	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	1	1
S_{19}	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0
S_{20}	1	1	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	0	0	1	0	1	0	0	1	1
S_{21}	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	1	0	0	0	1	0	1	0	1	1
S_{22}	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
S_{23}	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
S_{24}	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
S_{25}	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
S_{26}	1	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

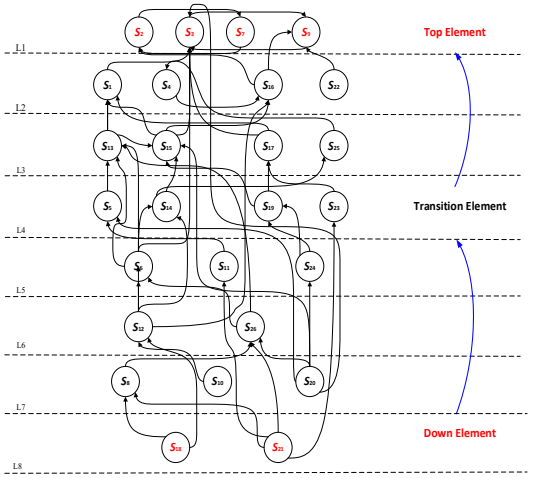

Figure 1. ISM Interpretation Structure Hierarchy

As can be seen from Figure 1,the factors affecting the barriers to the promotion of the digital economy in less developed regions constitute a system that can be categorized into surface,middle,and deep factors,reflecting the logical relationship between the factors affecting the barriers to the promotion of the digital economy.The surface layer factors are mostly factors of digital economy infrastructure and digital divide,which are the direct causes of the obstacles to the promotion of digital economy in less developed regions.Mid-level factors are mostly external factors such as the economic environment,some cultural and social factors,and governmental factors,which play a role in the ISM structure and are the indirect causes of the obstacles to the promotion of the digital economy in less developed regions.The deeper factors are mostly policy support,lack of talent introduction,and other factors and are the root causes of the obstacles.

The surface factors are the first and second layers,including S_2 ,S_3 ,S_7 ,S_9 ,S_1 ,S_4 ,S_{16} ,and S_{22} ,which are the direct factors hindering the promotion of the digital economy in underdeveloped regions,and are the direct manifestations of the middle and deep factors.The middle layer factors are the third to the sixth layer,including S_{13} ,S_{15} ,S_{17} ,S_{25} ,S_5 ,S_{14} ,S_{19} ,S_{23} ,S_{25} ,S_5 ,S_{14} ,S_{19} ,and S_{23} ,which are the factors that carry on the barriers to the promotion of the digital economy in less developed regions.The main sources of the middle layer factors are some external factors,such as the lack of support from financial institutions (S_{11}) which leads to the low digital payment and financial infrastructure (S_5),which in turn limits the market demand and consumption capacity of the underdeveloped regions (S_{13}),which further leads to the low social cognition and acceptance of the digital economy in the underdeveloped regions (S_{15}),and low digital literacy of the farmers (S_{16}),which ultimately impedes the barriers to the promotion of the digital economy.The deeper factors are the seventh and eighth layers,including S_8 ,S_{10} ,S_{20} ,S_{18} ,and S_{21} ,which are the fundamental obstacle factors to the promotion of a digital economy in less developed regions.The deep-seated obstacles of lack of professionals,imperfect education system and irrational economic structure must be taken from the deep-seated factors in the identification of path barriers to the promotion of digital economy in underdeveloped regions.

4.2. MICMAC Calculations and Analysis

According to the MICMAC model,combined with the calculation of the reachable matrix to get the value of each indicator according to the driving force and dependence,all the influencing factors are divided into different quadrants,and it is found that the obstacles of the path of the promotion of the digital economy in the underdeveloped region can only be categorized into three kinds of influencing factors,including spontaneous factors,linkage factors,and independent factors.MICMAC analysis is conducted for each factor influencing the promotion of the digital economy in underdeveloped regions.The MICMAC result chart x is as follows:

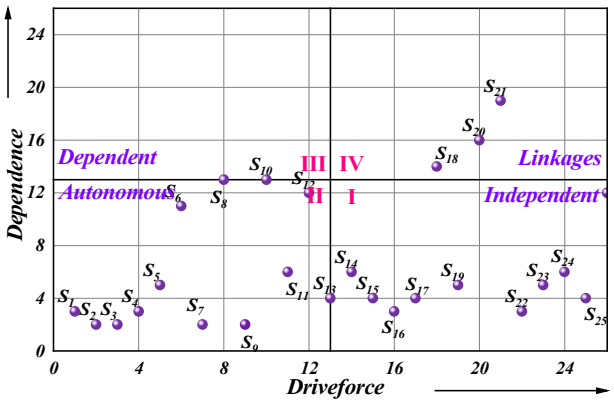

Figure 2. Driver-Dependency Analysis

As can be seen from Figure 2,spontaneous factors include incomplete infrastructure (S_1),low level of rural IT application (S_2),imperfect supporting facilities (S_3),rigid operation of network service platforms (S_4),little digital payment and financial infrastructure (S_5),late start of digital IT (S_6),lack

of rural digital technology (S_7),lack of digital economy professionals (S_8),difficulties in data collection (S_9),lack of support from financial institutions (S_{11}),irrational socio-economic structure (S_{12}),low market demand and consumption capacity (S_{13}),and market size and demand (S_{14}),is in the second quadrant,playing the role of intermediary and correlation,and can influence the factors at its upper level,while at the same time being constrained by the factors at its lower level. The spontaneous group has the characteristics of low dependence and low driving force,in the spontaneous group elements focus on the intermediate layer elements.There is little association with the system,but the association is strong enough to be dealt with independently among the barriers to the promotion of the digital economy in less-developed regions.

Independent factors include: low market demand and consumption capacity (S_{13}),small market size and demand (S_{14}),social awareness and acceptance (S_{15}),low digital literacy (S_{16}),scarcity of social capital and cooperative networks (S_{17}),lack of social trust (S_{19}),insufficient interactions between governmental departments (S_{22}),more rigid urban and rural planning (S_{23}),relevant laws and regulations are still imperfect (S_{24}),and mismatch between science and technology production and demand (S_{25}).Compared with dependency,these influencing factors have a high driving force.These factors have a high driving force and a weak dependence on other risk factors,so the focus should be on avoiding the likelihood of these types of risks in dealing with the barriers to the promotion of the digital economy in less-developed regions.These factors can be regarded as the source of influence on the promotion of the digital economy,and not only are they not easy to control through other factors,but once they are undermined,a series of "butterfly effects" can occur,so they should be emphasized.

The linkage factors include: low market demand and consumption capacity (S_{18}),small market size and demand (S_{20}),social cognition and acceptance (S_{21}),located in the fourth quadrant,the factors in the linkage zone generally have high driving force and a high dependence at the same time,and their changes are very likely to have an impact on other factors and further have an impact on themselves,which is insufficiently stabilized.The MICMAC result map shows that only three of the influencing factors in this paper belong to this quadrant,indicating that the influencing factors obtained in this study are relatively stable.

4.3. Recommendations for the Development of the Digital Economy

Most of the superficial factors faced in the promotion of the digital economy are the inadequacy of the digital economy infrastructure.The government can increase investment in network infrastructure construction to improve the speed and stability of network connections.Infrastructure factors are shown as spontaneous factors in the MICMAC results,indicating that such factors are more independent and can be dealt with separately.The government can encourage and support the construction and development of data centers,improve data storage and processing capabilities,and train technical personnel to attract and promote data center investment and development.

Economic structure and cultural factors are important mid-level factors in the pathway barriers to the promotion of the digital economy.Middle-level factors are not only affected by the lowest level,but also can influence the upper-level factors,and play a connecting role among all the factors.In response to such obstacle factors,the government can increase the support for the transformation and upgrading of traditional industries and encourage enterprises to increase investment and innovation in digital transformation.At the same time,it can strengthen support and guidance for emerging industries and cultivate new momentum in the digital economy.The government can increase its support for digital cultural construction and encourage the creation and dissemination of digital content.

The policy and legal environment is a spontaneous factor that "pulls one hair and affects the whole body",affecting other factors and triggering a chain reaction.The government can formulate and improve laws and regulations on digital privacy protection,and strengthen the protection and supervision of personal information.At the same time,it should strengthen the supervision and

enforcement of enterprises and organizations to ensure the healthy development of the digital economy and the protection of users' rights and interests.

Lack of digital economy professionals,inadequate education system,and lack of financial support are the underlying factors hindering the promotion of the digital economy,the government can increase investment in the training of digital technology talents,and provide relevant education and training resources to cultivate more digital economy talents.

5. Conclusion

(1) Factors related to digital economy infrastructure are surface factors in the barriers to digital economy diffusion. External factors such as the economic environment, culture, and social environment are the middle-level factors of the barriers to the promotion of the digital economy. The lack of digital economy professionals, the relatively weak economic and social foundation, the insufficiently sound education system, the lack of financial support, and the low level of social cognition and acceptance are the core elements that impede the path of digital economy promotion, and the barriers to the promotion of the digital economy. Should the government increase investment in the training of digital technology talents, provide relevant education and training resources, and cultivate more digital economy talents?

(2) In the cultural and social background, the three factors of insufficient education system, lack of financial support, and low social cognition and acceptance belong to the linkage group of factors, with high driving force and dependence, and are easily affected by other factors in the system, and once changed, they will also trigger a chain reaction of changes in the factors of other dimensions; the digital economy infrastructure, digital divide, and the economic environment belong to the spontaneous group of factors, with low dependence and driving force, and can be solved independently; the policy and legal background and the obstacles of the science and technology innovation dimension belong to the independent group of factors, with low dependence but high driving force, and are important external factors affecting the promotion of digital economy. The digital economy infrastructure, digital divide, and economic environment factors belong to the spontaneous group of factors, with low dependence and driving force, are relatively independent, and can be solved separately; the policy and legal background and the obstacles in the dimension of science and technology innovation belong to the independent group of factors, with low dependence but the high driving force, and they are the important external factors affecting the barriers to the promotion of digital economy.

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