



Research on Interprovincial Digital Economy Policies Based on PMC Index Model

Taking Guangdong, Jiangsu, Zhejiang, and Shandong as examples

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Abstract. The digital economy is an essential engine driving the high-quality development of China's economy. The healthy development of the digital economy is inseparable from the scientific guidance and effective regulation of policies. This paper collected 794 digital economy policies at the national and provincial levels, used the BERTopic algorithm to extract digital economy policy topics, improved the PMC index model evaluation index system based on the policy topics, and evaluated and researched the digital economy policies of Guangdong, Jiangsu, Zhejiang and Shandong. This research found that the four provinces, under the guidance of the central government and based on the actual conditions of the provinces, have formulated policy lines with their own characteristics; at the same time, the policies also generally have issues such as unclear implementation paths and weak predictions of the long-term development of the digital economy. Finally, based on research findings, this paper summarizes the directions in which provincial digital economy policies can be optimized, in order to provide a reference for the supply of digital economy policies and improve policy effectiveness.

Keywords: digital economy; policy evaluation; PMC index model; interprovincial policy research

1 Introduction

The digital economy is an important opportunity for China to cope with the decline of traditional economic momentum and provides a new growth point for China's economic development. Since the rise of technologies such as the Internet of Things and cloud computing, the central and local governments have continued to optimize their digital economic policy layout and have achieved a series of remarkable results. With the deepening of development, the development of digital economy has increasingly higher requirements for the government's precise policy implementation capabilities. Evaluating and researching digital economy policies is an important way to improve scientific

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decision-making, improve policy quality, and improve the modernization of digital economy governance capabilities.

2 Research Status

The previous research on digital economy policy in academia mainly consisted of speculative theoretical discussions, focusing on the impact of digital economy on traditional economy, and studying and summarizing the reform direction of policy systems [1,2]. These studies have laid a research foundation for digital economy policy research. In recent years, the government has issued a large number of digital economy policies, which have formed a relatively complete policy system. At the same time, the development needs of the digital economy have placed increasing demands on the accuracy and scientific nature of policies. Therefore, quantitative research on policy content is the current focus of academic research. At present, research on digital economy policies mainly adopts the content analysis method, based on the theory of policy tools, to construct a multidimensional analysis framework, such as the "tool-goal" framework constructed by Yang Qiaoyun et al. [3], and the "subject-tool-cycle" framework constructed by Lei Hongzhu et al. [4]. Scholars code and classify policy texts based on the theoretical framework, study whether policy tools are imbalanced, whether policy priorities are biased, and how policy goals are achieved, and explore their reasons to provide reference for strengthening the supply of digital economy policies. These studies only focus on a single core of policy themes or tools, without comprehensively considering the multiple influencing factors of policy formulation and implementation. Policy evaluation is a good solution to this problem.

Policy evaluation can comprehensively evaluate policies from multiple dimensions, such as policy timeliness, policy perspective, policy focus and policy object, and further adjust policies based on the evaluation results. After long-term development, policy evaluation methods are diverse, and appropriate evaluation methods need to be selected for different evaluation purposes. For example, the evaluation of policy effects usually uses the double difference method, the composite control method, and so on [5]. This paper studies policy texts, and the PMC index model is currently the mainstream policy evaluation model. It can well balance the characteristics of operability, applicability, objectivity and scientificity, helping researchers to quickly grasp the advantages and disadvantages of policy content and providing data as a basis for analysis. The PMC index model has been widely applied to the evaluation of digital economy policies. For example, Cai Dongsong et al. [6], Sun Xianmin et al. [7], and Wang Jian et al. [8] evaluated the policies in Jilin, Heilongjiang, and Hubei, respectively, and explored how to further leverage the effectiveness of the policies to promote the development of the digital economy in the province. Some scholars have also used the PMC index model to compare digital economy policies across regions, such as Bu Lingtong et al. [9], who compared the differences in digital economy policies between the eastern and western regions, focusing on analyzing the shortcomings of policies in different regions.

The relevant research on evaluating digital economy policies within the province has achieved good research results, and the research methodology is also relatively mature;

however, the comparative research on interprovincial policies focuses on comparing the differences and reasons between regions with better economies and those with weaker economies, without further exploring and summarizing the experiences that each region can learn from each other.

3 Experimental Procedure

The specific experimental process of this paper is shown in Figure 1.

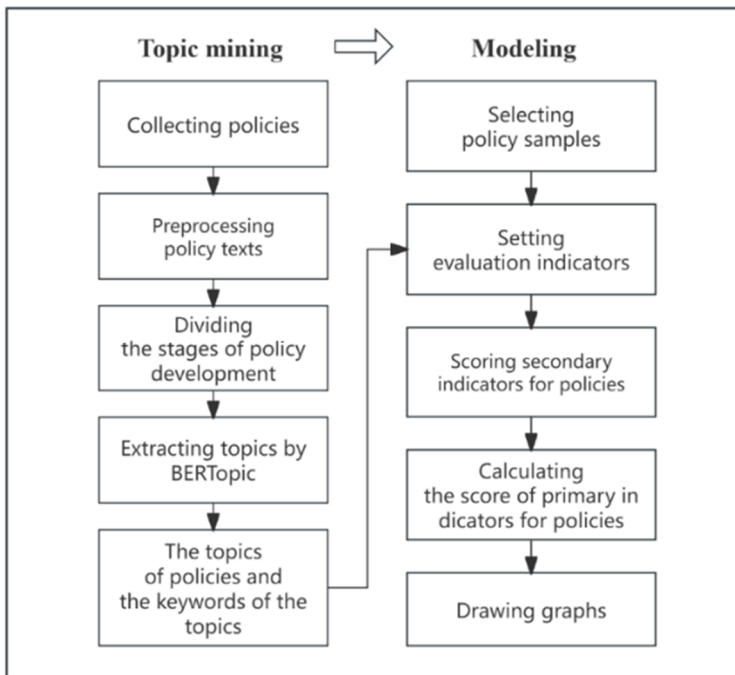


Fig. 1. Experimental procedure

3.1 Topic Mining

To ensure the effectiveness of subsequent evaluation indicators, a total of 794 national and provincial policies from January 2003 to December 2023 were retrieved and collected, divided into three stages, and policy hotspots were identified through thematic mining, which served as the basis for setting evaluation indicators. This paper uses BERTopic to perform topic mining on policy texts, and the specific mining process is shown in Figure 2.

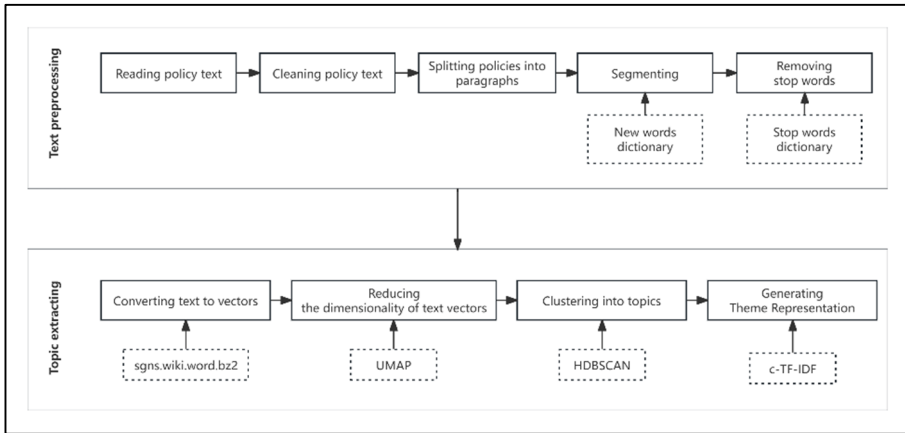


Fig. 2. BERTopic modeling procedure

Text Preprocessing.

First, the text is read and cleaned to remove invisible characters from the text; second, the text is divided into paragraphs and a paragraph is assigned to an object; then, the paragraph is segmented using the new words dictionary developed by the research group; finally, stop words are removed.

Topic Extracting.

First, "sgns.wiki.word.bz2" is used to convert policy paragraphs into semantic vectors; secondly, the UMAP algorithm is used to reduce the dimensionality of text vectors and solve the curse of dimensionality; then, the HDBSCAN algorithm is used for topic clustering, which clusters all paragraphs into multiple topic clusters; finally, the c-TF-IDF algorithm is used to extract keywords from each topic cluster. The algorithm assigns weights to each keyword based on global information, and selects keywords with higher weights as topic keywords to form a topic representation. Topics related to digital industrialization from the three stages of policies are selected as samples, as shown in Table 1.

Table 1. Policy topics related to digital industrialization

Policy Stages	Policy topics
Initial exploration stage (2003-2014)	Internet of Things/ Cloud computing/ Enterprise/ Technology/ Product
	Investment and financing/ Big data Industry/ Enterprise/ Guarantee
Rapid improvement stage (2015-2020)	Innovation/ Entrepreneurship/ Big data/ Digital Economy/ Innovation-driven
	Artificial intelligence/ Innovation/ Technology/ R&D/ Enterprise/ New generation
	Talent training/ Introduction/ Professional/ Leading talents/ Scientists

	Financing/ Enterprise/ Social capital/ Special Funds/ Key Projects
	Leading enterprises/ Big Data/ Software/ Investment attraction/ Model innovation
	Theory/ Knowledge/ Reasoning/ Perception/ R&D/ Key common technologies
	Smart sensor/ R&D/ Smart terminal/ Chip/ IC
	Industrial park/ Base/ Big data/ Industry-University-Research-Application Platform
	Culture/ Animation / Digital film and television / Creativity/ Games/ Music
Comprehensive development stage (2021-2023)	Chip/ Material/ Base/ Manufacturing/ Sensor/ Semiconductor
	Artificial intelligence/ Algorithm/ Model/ Technology/ Blockchain
	Talent/ Training/ Cultivation/ Digital skills/ Digital economy talents
	Digital economy/ R&D/ Core technology/ High-caliber talents/ Team/ Enterprise
	Digital/ Ecology/ Digital economy/ Future industries

3.2 PMC Modeling

Constructing an Evaluation Index System.

The PMC index model requires the establishment of primary and secondary indicators. Among them, the primary indicators such as policy attribute, policy timeliness, policy perspective, and their secondary indicators come from other scholars. The secondary indicators of policy focus and policy guarantee refer to the results of digital economy policy topic mining in Section 3.1. For example, the policy topic in the initial exploration stage is mainly focused on technology application, while in the rapid improvement stage and comprehensive development stage, there is increasing emphasis on core technology breakthroughs. Therefore, core technology breakthroughs are considered as a secondary indicator. Alternatively, the long-term issues that are the focus of the three policy stages are set as a secondary evaluation indicator, such as "digitalization of social services".

The evaluation index system is shown in Table 2.

Table 2. Digital economy policy evaluation indicators

Primary indicators	Secondary indicators	Reference
X1 Policy attribute	X1.1 Predict, X1.2 Advise, X1.3 Monitor, X1.4 Describe, X1.5 Guide, X1.6 Identify	Zhang Yong'an et al.[10]
X2 Policy timeliness	X2.1 Long term, X2.2 Medium term, X2.3 Short term	Hu Feng et al.[11]
X3 Policy perspective	X3.3 Macroscopic, X3.4 Mesoscopic, X3.3 Microscopic	Huang Pingping et al.[12]

X4 Policy evaluation	X4.1 Clear goals, X4.2 Scientific plans, X4.3 Sufficient evidence, X4.4 Reasonable planning	Bu Lingtong et al. [9]
X5 Policy focus	X5.1 Core technology breakthrough, X5.2 Key industry development, X5.3 Future industry layout, X5.4 Industrial ecological support, X5.5 Data factor circulation, X5.6 Data factor development and utilization, X5.7 New infrastructure construction, X5.8 Digitalization of social services, X5.9 Digital governance system, X5.10 Digital security system, X5.11 International cooperation/Interprovincial co-construction	Topic Mining
X6 Policy guarantee	X6.1 Special funds, X6.2 Financial incentives, X6.3 Criteria and specifications, X6.4 Talent training and introduction, X6.5 Systems and regulations, X6.6 Resource coordination	Topic Mining
X7 Policy target	X7.1 Government, X7.2 Enterprises, X7.3 Research institutions, X7.4 Universities, X7.5 Industry associations, X7.6 Researchers, X7.7 The public	Chen Qiang et al. [13]
X8 Policy operability	X8.1 Specific plan, X8.2 Division of tasks, X8.2 Supporting policies, X8.4 Clear responsibilities and powers	Han Ping et al.[14]
X9 Policy function	X9.1 Scientific research and innovation, X9.2 In-depth application, X9.3 Demonstration and leadership, X9.4 Achievement transformation	Hou Tiantian et al.[15]

Selecting Policy Samples for Evaluation.

According to the "China Digital Economy Development Index (2023)" by the Fifth Institute of Electronics of the Ministry of Industry and Information Technology, the four top-ranked GPD provinces of Guangdong, Jiangsu, Zhejiang, and Shandong were selected as policy sample sources. Based on the principles of timeliness and comprehensiveness, one planning guidance policy and one policy to promote planning implementation were selected from the policies of the four provinces. The samples are shown in Table 3.

Table 3. Samples of digital economy policy evaluation

Policy Number	Policy Name	Policy Source	Date of publication
P1	Guangdong Province Digital Economy Development Guidelines 1.0	Guangdong Province	2022-07
P2	Key Points for Guangdong Province's Digital Economy Work in 2023	Guangdong Province	2023-03
P3	Jiangsu Province's 14th Five-Year Plan for Digital Economy Development	Jiangsu Province	2021-08
P4	Guiding Opinions on Comprehensively Improving the Development Level of Digital Economy in Jiangsu	Jiangsu Province	2022-02
P5	Zhejiang Province's 14th Five-Year Plan for Digital Economy Development	Zhejiang Province	2021-06
P6	Key Points for Zhejiang Province to Promote High-Quality Development of Digital Economy in 2022	Zhejiang Province	2022-03

P7	Shandong Province's 14th Five-Year Plan for Building a Digital Power Province	Shandong Province	2021-07
P8	Shandong Province's 2023 Digital Economy "Comprehensive Improvement" Action Plan	Shandong Province	2023-04

Evaluating Policies and Calculating Scores.

Evaluating policies is to research the policy and determine whether the policy involves the content corresponding to the secondary indicators. If it is involved, the corresponding indicator will be marked as 1, otherwise the indicator score will be recorded as 0. The first-level indicator score is the mean score of its corresponding second-level indicator. The calculation method is shown in Formula (1).

$$X_i = \sum_{j=1}^n \frac{X_{ij}}{T(X_{ij})} \tag{1}$$

Where i is the sequence number of the primary variable, j is the sequence number of the secondary variable, and n is the number of secondary variables contained in the i -th primary variable, and $T(X_{ij})=n$.

4 Analysis of Experimental Results

The average score of the first-level policy variable in each province is calculated, and the score of interprovincial policies is plotted, as shown in Figure 3. To facilitate comparison, the scores of the secondary variables of interprovincial policies are plotted as shown in Figure 4. This figure can visually compare the details of the scores and losses of each policy, and further compare the policy texts to explore the reasons.

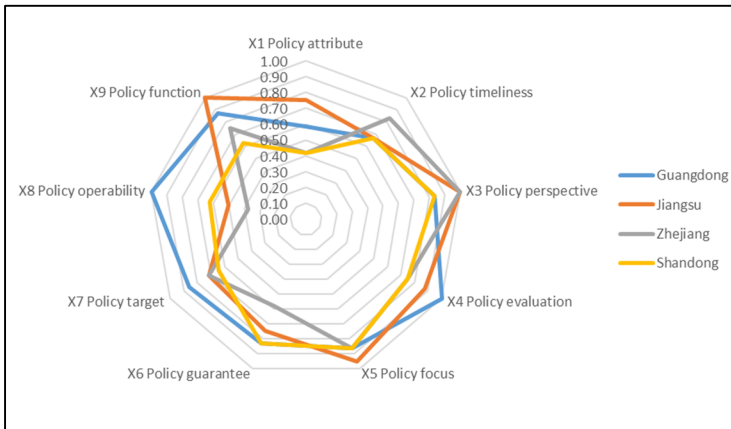


Fig. 3. Interprovincial comparison of mean scores of primary indicators

Jiangsu's digital economy policy also reflects this feature: As can be seen from Figure 2, the three first-level indicators of policy attribute, policy focus and policy function score better than other provinces. According to Figure 3, it can be seen that the higher score lies in strengthening the prediction of the development situation, and paying more attention to international cooperation, and accelerating the layout of future industries, and strengthening the R&D of the underlying technology and core technology in the frontier areas of future networks, quantum information, 6G, meta-universe, etc., and accelerating the verification of the results and pilot applications. In terms of policy functions, compared with the policies of other provinces, Jiangsu pays more attention to guiding scientific research institutes to jointly carry out research and development work with universities and enterprises, innovating the achievement transformation mechanism, building achievement transformation demonstration areas and achievement industrialization bases, and strongly creating new potential for the development of the digital economy. In addition, Jiangsu's policies comprehensively focus on the cultivating of digital talents, focusing on teacher training and curriculum design in higher education, technical personnel training in enterprises, and leadership talent cultivation. It also vigorously invests in various key laboratories and innovative infrastructure, constructs a technology achievement trading service market to promote achievement transformation, and strives to break through technological bottlenecks to seize future technological opportunities, and lead the development of the national digital economy.

Zhejiang's digital economy policy takes the overall situation into consideration better than other provinces. As early as 2003, Zhejiang started the construction of "Digital Zhejiang". In 2013, Zhejiang became the only national information economy demonstration zone. In 2018, a national digital economy demonstration province construction plan was formulated and implemented. In 2021, Zhejiang was designated as the country's first common prosperity demonstration zone. Due to the "Digital Zhejiang" strategy and the positioning of a national demonstration zone, Zhejiang adheres to a blueprint to the end, and its digital economy policies have significant characteristics of comprehensiveness and overall planning: as shown in Figure 2, the policy effectiveness and perspective of Zhejiang's policies are superior to those of other regions. From Figure 3, it can be seen that in terms of policy timeliness, the long-term and short-term planning of policies is coherent, which is conducive to the sustained and effective implementation of policies. In terms of policy perspective, at the macro level, it covers all areas of the digital economy; at the meso level, the development focus of each field is deployed; at the micro level, it can clarify the specific development results to be achieved and plan the overall route for the development of the digital economy. Policy timeliness and policy perspective reflect the two dimensions of policy time and level. From the above analysis, we can see that Zhejiang's digital economic policy focuses on creating a digital economic development pattern that is vertically connected and horizontally linked. For example, proposing the construction of a digital economy system, promoting the construction of industrial brains, and separately listing the top-level design as a key task; at the same time, attention can be paid to more specific tasks, such as using digital economy platforms to organize competitions, innovating systems to improve

employment services, or improving digital social services for special groups, with detailed and comprehensive policies.

Shandong Province's digital economy policy has a balanced performance in all aspects. After entering the "14th Five-Year Plan" period, Shandong has established the overall idea of becoming a digitally strong province of "one year to gain overall momentum, two years to make key breakthroughs, and five years to leapfrog the lead." In 2021 and 2022, Shandong has launched a series of action plans such as "key breakthroughs" in the digital economy, digital transformation and innovation, and digital empowerment and efficiency improvement, rapidly improving the level of the digital economy and ranking among the top in the country. On this basis, Shandong has designated 2023 as the year of "comprehensive improvement" of the digital economy, and plans to establish 2024 as the year of "innovation and attack". It can be seen from Figure 2 that although Shandong's policies do not have particularly outstanding high-scoring items, they also do not have outstanding shortcomings. Compared with other provinces, the scores of its policy indicators are significantly more balanced, and the scores of all indicators are above the average level. It shows that Shandong's policy thrust is highly stable and all aspects of the policy have gathered together to form a strong synergy, which has strongly promoted the leap development of the province's digital economy. Observing Figure 3, in terms of policy focus, compared with other provinces, Shandong has better coverage of all aspects of the digital economy, especially the policies of the "comprehensive improvement" year. The action plan and development achievements for the development of digital economy in Shandong Province indicate that focusing on breakthroughs in various fields, promoting the formation of a good linkage foundation between various fields, and then comprehensively enhancing the development of digital economy is an effective path for the development of digital economy. Provinces in the middle to lower level of digital economy development can refer to Shandong's experience and formulate development paths tailored to local conditions.

4.2 Analysis of Insufficient Interprovincial Policies

Observing Figure 3, it is found that policies generally lose points in some secondary indicators of policy attribute, policy target, and policy operability. In terms of policy nature, "predict", "advise", and "monitor" tend to lose more points, while "descript", "guide", and "identify" score more, indicating that the policy focuses on identifying and analyzing the current development challenges of the digital economy and providing corresponding guidance. However, the long-term prediction of the digital economy, suggestions for development layout, and supervision of the digital economy development process are relatively weak. Therefore, improving the predictability and targeting of policies can be taken as the optimization direction. In terms of policy targets, comparing various secondary indicators, it is found that the policy focuses on promoting cooperation between the government, enterprises, research institutions, and universities, while there is room for optimization in mobilizing and leveraging the service coordination function of industry associations and stimulating the innovative vitality of scientific researchers. In terms of policy operability, policies in each province have provided specific plans and supporting measures for the development of the digital

economy. However, most policies need to be improved in decomposing and allocating tasks and clarifying the rights and responsibilities of all parties involved in policy implementation, which to some extent affects policy implementation.

There are few special points lost in each province's policies. The more prominent one is that Shandong's policies lose points in "international cooperation/interprovincial co-construction", while Guangdong, Jiangsu and Zhejiang all have plans for this. Further exploring the policy text, on the international cooperation, Guangdong encourages enterprises and scientific research institutions to strive for international cooperation projects in software development, big data services, digital finance, etc.; Jiangsu focuses on building an important global exhibition and high-end dialogue platform for the digital economy; Zhejiang relies on the "Belt and Road" Promote digital service content, format and business model innovation and product output. On the interprovincial front, Guangdong is joining hands with Hong Kong and Macao to jointly build a digital technology innovation platform, interconnect computing power networks, and strive to create a global digital trade pilot area; Jiangsu and Zhejiang are accelerating the complementary advantages of the Yangtze River Delta in the industrial chain and promoting the integration of digital infrastructure Construction, promoting regional data circulation, sharing, development and utilization. Therefore, interprovincial co-construction mainly relies on the regional division of national urban clusters, while the Shandong Peninsula urban cluster is limited to the province. It can be found that interprovincial co-construction mainly relies on the regional division of national urban clusters, while the Shandong Peninsula urban cluster is limited to within the province. Therefore, Shandong needs to innovate interprovincial co-construction channels and mechanisms to achieve complementary advantages, resource sharing, and coordinated development with other provinces and regions.

5 Conclusions

Through the above comparative analysis of interprovincial policies, it can be reasonably extended to digital economic policies across the country, and the following policy implications can be summarized as the basis for optimizing digital economic policies in various places.

In response to the common issue of weak operability in policies, reference can be made to Guangdong's experience in digital economy policies, such as summarizing excellent experiences within the province and even nation to ensure the effective implementation of policies. Specifically, based on the excellent cases compiled by research institutions such as the China Academy of Information and Communications Technology, combined with the development direction and needs of the province, a professional team can be organized to study the development experience of high-level digital economy provinces in the eastern region, and exchange with similar provinces. Develop a set of effective and easy-to-propagate best practice examples outside and within the province, and communicate them to policy implementing agencies in the form of policy appendices, construction guidelines or task execution manuals to improve policy implementation efficiency. In addition, a policy implementation

framework can be established to break down tasks, track progress, assign executing units, refine tasks, establish frameworks, ensure accountability, and make smooth connections. If policy implementation is inadequate, timely accountability, feedback, and adjustments can be conducted.

To address the common problem of weak policy predictability, Jiangsu's digital economy policy experience can be referred to. The forward-looking feature of Jiangsu's policies is reflected in many aspects. First, policy formulation should be based on sorting out the early development and development status of the digital economy, strengthening long-term forecasts of the digital economy so that to formulate policies from a more scientific and systematic perspective; the second is to actively experiment in the frontier areas of the digital economy based on the province's development foundation, and promote and complement each other with existing characteristic industries; the third is to strengthen international exchanges, grasp the international frontier trends of the digital economy, turn passivity into initiative, and seize development opportunities. Based on this, recommend local govts to set up digital economy monitoring and analysis systems, using big data and AI to collect real-time data on market transactions and tech innovations. Organize a professional team of government think tanks, business experts and industry talents to analyze digital economy data and develop practical policies. Establish an information group to participate in international and interprovincial digital economy exchanges, collect frontier information and forecast trends to improve policy foresight.

With reference to Shandong's insufficient digital economy policies, provinces with similar situations can strengthen interprovincial co-construction and coordinated development. At present, the interprovincial joint construction of digital economy mainly relies on the regional division of urban clusters. Provinces in the interprovincial urban cluster can actively build interconnected digital infrastructure based on the national strategy to facilitate data and technology flow and promote the complementary advantages of the digital economy. Provinces such as Shandong and Liaoning, which are limited to intra-provincial urban agglomerations, can innovate interprovincial cooperation models for cross-regional resource integration. Furthermore, the central region can analyze the industrial advantages of different regions, clarify the positioning and development direction of all provinces in the industrial chain, and sign cooperation agreements with regions such as the Yangtze River Delta, and accelerate the exploration of complementary and mutually beneficial cooperation models and paths in infrastructure interconnection, industrial chain integration, industrial cooperative innovation, technology transfer, and product research and development; Collaborate with western provinces such as Guizhou and Ningxia, which have abundant energy resources and strong data and computing power service industries, to jointly undertake large-scale international and interprovincial projects with high demand for data processing capabilities and computing power resources. In addition, various regions should accelerate information sharing and business interoperability. The central, western and eastern provinces should establish a resource sharing mechanism through interprovincial cooperation, create an integrated platform in areas such as government services, employment and education, promote information transparency, and facilitate talent mobility and interprovincial business for enterprises.

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