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The Impacts of Digital Economy on Balanced and Sufficient Development in China: A Regression and Spatial Panel Data Approach

Xiangyu Ge [1], Zunrong Zhou [1,2], Xia Zhu [1,*], Yonghong Wu [2] and Yanli Zhou [3]

[1] School of Statistics and Mathematics, Zhongnan University of Economics and Law, Wuhan 430073, China
[2] Department of Mathematics and Statistics, Curtin University, Perth, WA 6845, Australia
[3] School of Finance, Zhongnan University of Economics and Law, Wuhan 430073, China
* Correspondence: xzhu@zuel.edu.cn

Abstract: The digital economy can change the proportions and types of production factors, gradually replace traditional backward production factors, reconstruct the division of labor and cooperation system, and improve productivity, which is an important basis for balanced and sufficient development. This paper measures the comprehensive level of the digital economy and balanced and sufficient development, by using Chinese provincial panel data from 2013 to 2021, and uses the panel fixed effect model, mediation effect model, and spatial econometric model to examine the digital economy's effect on balanced and sufficient development as well as the digital economy's mechanism. The results show that the digital economy has significantly promoted balanced and sufficient development, though there are obvious regional heterogeneity and spatial spillover effects, and the relevant conclusions are still valid after an endogenous treatment and a robustness test. The total factor productivity is an important mechanism for the digital economy to affect balanced and sufficient development.

Keywords: digital economy; balanced and sufficient development; mediation effect model; spatial econometric model

MSC: 62-07; 62H11; 62H12

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1. Introduction

Since the reform and opening up, China has promoted labor-intensive industries in a short period of time by relying on population and policy dividends and has achieved strong international competitiveness. It has been hailed as the world's manufacturing factory, which has been miraculous for China's economic growth. However, some deep-rooted problems accumulating over a long period of time have gradually emerged, especially the problem of unbalanced and insufficient development. At the same time, with the continuous development of China's economy, people's needs for a better life are increasing. As pointed out in the report of the 19th National Congress of the Communist Party of China, the principal contradiction in China is now between the people's growing needs for a better life and the unbalanced and insufficient development. Therefore, how to solve the problem of unbalanced and insufficient development is of great practical significance to China.

The digital economy may be a good starting point. According to the National Bureau of Statistics of China, the digital economy refers to a series of economic activities that use data resources as key factors of production, modern information networks as important carriers, and the effective use of information and communication technologies as an important driving force for efficiency improvement and economic structure optimization. The digital economy can reorganize production factors and reshape the economic structure during the

process of its deep integration with various fields of China's economy. Therefore, China attaches great importance to the development of the digital economy, and the term digital economy frequently appears in various important conferences and work reports. In recent years, the digital economy has developed rapidly in China. According to the "White Paper on the Development of China's Digital Economy (2022)", released by the China Academy of Information and Communications Technology, the scale of the digital economy in 2021 reached RMB 45.5 trillion, accounting for 39.8% of the GDP, and the growth rate of the digital economy was 16.2%, which was much higher than the growth rate of the GDP.

What impact does the digital economy have on balanced and sufficient development? How effective is the impact of the digital economy? Has it narrowed the gap of unbalanced and insufficient development? What is the transmission mechanism behind it? Some scholars have carried out research on the impact of the digital economy from the perspective of total factor productivity, innovation capacity, industrial structure upgrading, high-quality economic development, and coordinated development, but studies from the literature mainly focused on the subtopics of balanced and sufficient development. Regarding total factor productivity, Tian and Liu [1] and Wu and Yu [2] found that the digital economy can promote it. Guo et al. [3] and Pan et al. [4] explored how the mechanism of the digital economy affected total factor productivity. Moreover, Deng et al. [5] and Yang and Jiang [6] pointed out that the digital economy had a spatial effect on total factor productivity. Regarding innovation capacity, Wen et al. [7] and Xiong and Cai [8] found that the digital economy had a positive effect on regional innovation capacity. Regarding industrial structure upgrading, Su et al. [9], Liu et al. [10], and Zhao et al. [11] indicated that the digital economy can promote industrial structure upgrading, while Wu and Yang [12] explored this influence from a subdivided perspective (employment structure). Regarding high-quality economic development, Ding [13] and Ge and Wu [14] theoretically analyzed the influence of the digital economy on it. Li and Yang [15] and Zhang et al. [16] empirically found that the digital economy can promote high-quality economic development. Ding et al. [17], Ma and Zhu [18] and Zhao et al. [19] further analyzed how the mechanism of the digital economy affected high-quality economic development. Regarding coordinated development, Zhong and Zheng [20] analyzed the influence of the digital economy on it and found that the digital economy can promote coordinated development.

In order to accurately answer the influence of the digital economy on the balanced and sufficient development as well as the digital economy's specific mechanism, it is necessary to consider the actual situation and conduct empirical research on the basis of theoretical guidance. Thus, this paper measures the comprehensive level of balanced and sufficient development and the digital economy from 2013 to 2021 and uses econometric methods to empirically investigate the impact of the digital economy on the balanced and sufficient development as well as the digital economy's mechanism. The major contributions are as follows. First, this paper considers balance and sufficiency to comprehensively reflect the level of BSD at the provincial level in China. Second, this paper uses balanced panel data to explore the impact of the digital economy on balanced and sufficient development as well as the digital economy's mechanism. Moreover, we use the spatial Durbin model to analyze the impact of the digital economy on balanced and sufficient development, thus forming a relatively complete and rigorous research system. Third, this paper illustrates the new benefits of the digital economy and provides a new way to achieve balanced and sufficient development, thus providing a basis for theoretical research on formulating macroeconomic policies.

This paper is arranged as follows. The theoretical analysis and research hypothesis are presented in Section 2. The level of balanced and sufficient development at the provincial level in China is measured in Section 3. The modeling design is listed in Section 4. The empirical results in terms of benchmark regression, endogeneity test, robustness test, and mechanism analysis are correlated in Section 5. The spatial panel Durbin model is used to further analyze the influence of the digital economy in Section 6, and conclusions are offered in Section 7.

2. Theoretical Analysis and Research Hypothesis

Looking at the previous technological changes, they can all bring about progress in social productivity. Due to the characteristics of penetration and integration, the digital economy can change the proportions and types of factors, gradually replace traditional and backward production factors, then improve productivity, and finally promote upgrading the industrial structure. In addition, considering that the Internet has the characteristics of increasing the marginal effects of network spillovers, we believe that the digital economy may have spatial spillover effects on balanced and sufficient development. Therefore, this paper will mainly analyze the impact of the digital economy on balanced and sufficient development from two aspects, the mechanism and the spatial spillover effect, and put forward corresponding research hypotheses.

2.1. Mechanism of Digital Economy Affecting Balanced and Sufficient Development

As an integrated economy, on the one hand, the digital economy takes data as the core production factor, penetrates into all production links, and gradually changes the types and proportions of the factor inputs in the production process. It can break the shackles of the traditional factor market and reduce resource misallocation and market distortion by intensifying market competition and optimizing industries. In addition, the reduction in resource misallocation and market distortion helps to increase total factor productivity. On the other hand, the digital economy also uses modern information networks as an important carrier. Through the effective use of information and communication technologies, people can establish a series of public service platforms and databases, which can improve the efficiency of knowledge dissemination, reduce information asymmetry in the technology market, and provide diversified opportunities for technological innovation personnel, thus increasing total factor productivity. According to Solow's economic growth model, technological innovation is the source of power for economic growth. Therefore, the improvement of total factor productivity including technological innovation should also be conducive to balanced and sufficient development. Based on the above analysis, this paper puts forward research hypothesis 1:

Hypothesis 1: *The digital economy can have a positive effect on balanced and sufficient development by promoting total factor productivity*.

2.2. Spatial Spillover Effect of Digital Economy on Balanced and Sufficient Development

The digital economy can break through the limitations of geographical factors, realize cross-regional division of labor and cooperation, and then enhance the breadth and depth of regional economic ties. Relevant research based on the background of China also sup-ports the conclusion that the Internet has spatial spillovers. Some scholars have elaborated on this. Yilmaz et al. [21] conducted an empirical test on the panel data of 48 states in the United States, and paid attention to the spatial spillover effect brought about by informatization earlier. Keller [22] supplemented the discussion of spillover distance from the perspective of knowledge and technology diffusion. Relevant research based on the background of China also supports the conclusion that the Internet has spatial spillovers (see Yan and Ma [23], Bian [24], Li and Wang [25]). Regional economic activities also have obvious spatial correlations. For example, the Internet has spatial spillover effects on regional economic development in terms of economic growth (see Lin et al. [26], Zhang et al. [27]), resource misallocation (see Han and Zhang [28]), and digital finance (see Guo et al. [29]). Then, the influence of the digital economy including the Internet on BSD should also have spillover effects in space. Therefore, this paper proposes research hypothesis 2:

Hypothesis 2: *The digital economy can affect the BSD of neighboring regions through spatial spillover effects*.

3. Measurement of Balanced and Sufficient Development

This section estimates the level of balanced and sufficient development at the provincial level in China, from the perspectives of balance and sufficiency, and comments on the temporal and spatial characteristics of balanced and sufficient development.

3.1. Establishment of Evaluation Index System of Balanced and Sufficient Development

Regarding unbalanced development, some scholars consider that unbalanced development refers to the inability to meet the growing needs of the people for economic and social equity, which is reflected in the fact that the people cannot equally enjoy the fruits of socialist construction (see Wang and Lin [30] and Wang et al. [31]), especially in the fields of culture, education, healthcare, and pension (see Hu and Yan [32] and Xu et al. [33]). In terms of insufficient development, some scholars believe that insufficient development is demonstrated by the fact that the production factors of China have not been fully utilized, which makes it difficult to meet people's expectations for various products and services, social equity, and an ecological environment [31,32].

Therefore, based on the existing literature, we think that balanced development refers to the balance of people's living standards and social welfare, and sufficient development refers to the regional economic development strength and people's income and consumption. Then, we select 16 indicators to construct an evaluation index system of balanced and sufficient development, with eight dimensions based on the existing research (Table 1).

Table 1. The evaluation index system of balanced and sufficient development.

Comprehensive Indicators	Level 1 Indicators	Level 2 Indicators	Level 3 Indicators	Attribute
Balanced and sufficient development	Balanced development	Culture and education	Public library collections per capita	Positive
			Years of schooling per capita	Positive
		Transportation facilities	Private car ownership per 100 people	Positive
			Public transportation vehicles per 10,000 people	Positive
		Healthcare	Number of beds in medical institutions per 10,000 people	Positive
			Number of health technicians per 10,000 people	Positive
		Pension security	Pension insurance coverage	Positive
			Pension replacement rate	Positive
	Sufficient development	Economic development	GDP per capita	Positive
			GDP growth rate	Positive
		Development basis	Railway density	Positive
			Road density	Positive
		Income distribution	Per capita disposable income	Positive
			Per capita disposable income ratio of urban and rural residents	Negative
		Consumption level	Per capita consumption expenditure	Positive
			Per capita consumption expenditure ratio of urban and rural residents	Negative

A positive attribute represents that the greater the value of the index is, the more it can reflect balanced and sufficient development. A negative attribute indicates that the larger the value of the index is, the more it can reflect unbalanced and insufficient development. The indicator data come from the *China Statistical Yearbook*. The samples are 30 provinces and do not include Tibet, Hong Kong, Macao, and Taiwan. The interval of time is from 2013 to 2021. The data involving the price factor are all converted to the actual value, with 2013 as the base period, by using the CPI deflator.

Determining the level of balanced and sufficient development requires not only the specific indicators that are available but also the weights assigned to these indicators. The existing weighting methods mainly include subjective and objective weighting methods, but subjective weighting may be affected by subjective factors. Therefore, the entropy method in the objective weighting method is selected to assign the weights. Since there are

significant differences in the scale and order of magnitude of the 16 indicators in Table 1, these indicators need to be standardized to facilitate the comparison of balanced and sufficient development in different provinces in different years.

In this paper, the positive and negative indicators are treated as follows.

$$\text{Positive indicators}: \ z_{ijt} = \frac{x_{ijt} - \min\{x_{ijt}\}}{\max\{x_{ijt}\} - \min\{x_{ijt}\}} \tag{1}$$

$$\text{Negative indicators}: \ z_{ijk} = \frac{\max\left\{x_{ijk}\right\} - x_{ijk}}{\max\left\{x_{ijk}\right\} - \min\left\{x_{ijk}\right\}} \tag{2}$$

Among these, $\max\{z_{ijt}\}$ and $\min\{z_{ijt}\}$ are the maximum and minimum values of indicator i in all years in all provinces, respectively, where $i = 1, 2, \cdots, \mathrm{M}$ refers to M evaluation indexes, $j = 1, 2, \cdots, \mathrm{N}$ means N provinces, and $t = 1, 2, \cdots, \mathrm{T}$ for the time span of T.

The proportion of the standardized metrics is calculated as

$$\varphi_{ijt} = \frac{z_{ijt}}{\sum_{j=1}^{N}\sum_{t=1}^{T} z_{ijt}} \tag{3}$$

The information entropy of index i is calculated as

$$e_i = -\frac{1}{\ln(N \times T)} \sum_{j=1}^{N}\sum_{t=1}^{T} \varphi_{ijt} \times \ln(\varphi_{ijt}) \tag{4}$$

The information entropy redundancy of index i is calculated as

$$d_i = 1 - e_i \tag{5}$$

The weights of the indicators i are calculated as

$$w_i = \frac{d_i}{\sum_{i=1}^{M} d_i} \tag{6}$$

Finally, the level of balanced and sufficient development for each province for each year is calculated as

$$BSD_{jt} = \sum_{i=1}^{M}\sum_{j=1}^{N}\sum_{t=1}^{T} z_{ijt} \times w_i \tag{7}$$

Formula (7) is based on the standardized indicators z_{ijt} and the weight w_i, where BSD_{jt} indicates the level of balanced and sufficient development of province j in year t, and the value ranges from 0 to 1.

3.2. Assessment of Balanced and Sufficient Development

3.2.1. Descriptive Analysis of Balanced and Sufficient Development

Based on Section 3.1, we calculate the level of balanced and sufficient development from 2013 to 2021. Due to limited space, we only show the data of some years (Table 2).

On the whole, the average level of China's balanced and sufficient development in-creases from 0.207 to 0.335, with an average annual growth rate of 6.22%, and each province also shows significant improvement. Regionally, the western regions have the fastest growth rate of balanced and sufficient development with an average annual growth rate of 7.73%, followed by the central regions with a rate of 7.36%, while the eastern regions are at the bottom, with a rate of 5.04%. In terms of the level of balanced and sufficient development, the eastern regions have the largest number for the annual data, followed

by the central regions, while the western regions have the smallest number for the annual data, which is completely opposite to the ranking of the average annual growth rate.

Table 2. The data of balanced and sufficient development for selected years.

Regions		2013	2015	2017	2019	2021	Average Annual Growth Rate
Nation	Average value	0.207	0.239	0.273	0.303	0.335	6.22%
Eastern regions	Beijing	0.477	0.493	0.537	0.556	0.593	2.81%
	Tianjin	0.381	0.391	0.434	0.440	0.483	3.05%
	Hebei	0.185	0.215	0.249	0.268	0.298	6.14%
	Liaoning	0.212	0.247	0.277	0.301	0.333	5.82%
	Jilin	0.169	0.193	0.216	0.235	0.287	6.91%
	Heilongjiang	0.154	0.172	0.203	0.232	0.272	7.40%
	Shanghai	0.506	0.535	0.583	0.605	0.643	3.07%
	Jiangsu	0.278	0.318	0.363	0.396	0.434	5.75%
	Zhejiang	0.283	0.328	0.369	0.407	0.426	5.28%
	Fujian	0.214	0.252	0.288	0.323	0.353	6.46%
	Shandong	0.239	0.273	0.308	0.339	0.371	5.66%
	Guangdong	0.209	0.244	0.283	0.306	0.331	5.99%
	Hainan	0.151	0.192	0.222	0.258	0.295	8.78%
	Average value	0.266	0.296	0.333	0.359	0.394	5.04%
Central regions	Shanxi	0.175	0.191	0.219	0.253	0.291	6.58%
	Anhui	0.177	0.213	0.249	0.290	0.331	8.16%
	Jiangxi	0.152	0.178	0.216	0.249	0.290	8.43%
	Henan	0.179	0.214	0.248	0.285	0.305	6.90%
	Hubei	0.203	0.240	0.270	0.306	0.338	6.63%
	Hunan	0.177	0.223	0.254	0.302	0.320	7.80%
	Average value	0.177	0.210	0.243	0.281	0.313	7.36%
Western regions	Inner Mongolia	0.154	0.184	0.218	0.251	0.282	7.85%
	Guangxi	0.109	0.151	0.179	0.208	0.243	10.66%
	Chongqing	0.191	0.235	0.276	0.314	0.348	7.83%
	Sichuan	0.156	0.182	0.215	0.245	0.261	6.71%
	Guizhou	0.108	0.150	0.183	0.220	0.241	10.74%
	Yunnan	0.108	0.140	0.172	0.207	0.234	10.21%
	Shaanxi	0.269	0.319	0.368	0.413	0.454	6.79%
	Gansu	0.094	0.113	0.136	0.177	0.202	10.08%
	Qinghai	0.143	0.155	0.188	0.210	0.236	6.54%
	Ningxia	0.183	0.219	0.255	0.269	0.291	6.01%
	Xinjiang	0.173	0.198	0.215	0.237	0.264	5.39%
	Average value	0.153	0.186	0.219	0.250	0.278	7.73%

According to the balanced and sufficient development of each province, Shanghai, Beijing, Tianjin, Jiangsu, and Zhejiang are the leaders in 2021, while Guangxi, Guizhou, Yunnan, and Gansu rank in the first line for average annual growth rate, all over 10%, and the balanced and sufficient development is rapid, but the interprovincial gap is still more prominent. For example, Shanghai's balanced and sufficient development level (0.506) was five times higher than that of Gansu (0.094) in 2013, which was narrowed to three times higher in 2021, indicating that while the interprovincial gap is still large, the gap is narrowing.

3.2.2. Spatial Correlation Analysis of Balanced and Sufficient Development

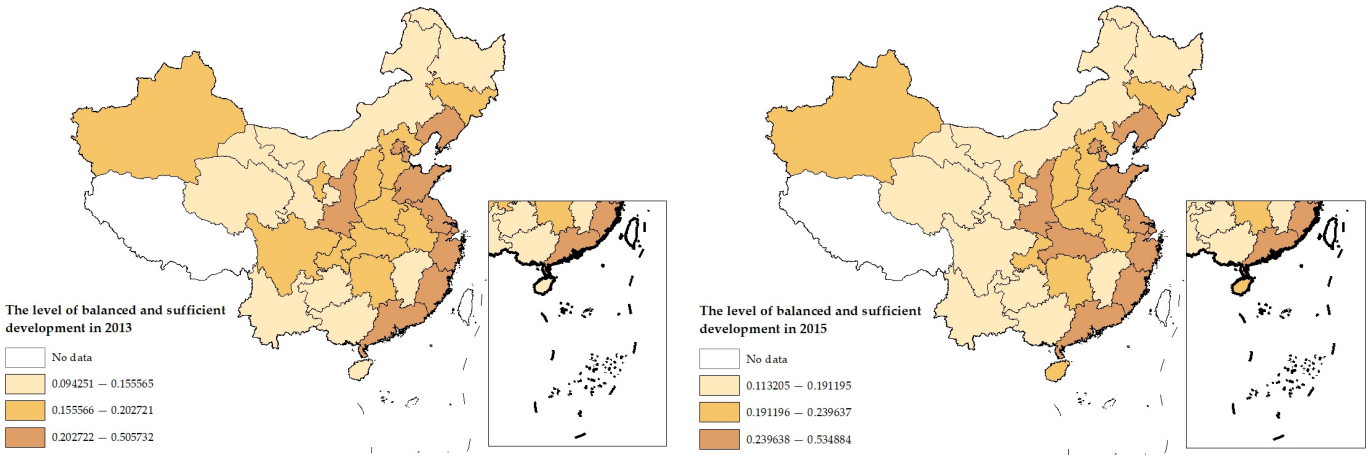
Along with the continuous increase of time, there is a significant spatial correlation with the balanced and sufficient development among each province. We use the global Moran's Index to test the spatial correlation of balanced and sufficient development, and the spatial adjacency matrix is selected as the weight matrix. The test results are shown in Table 3. The p value of the Moran's Index of balanced and sufficient development in all years is positive and less than 0.01, which indicates that there is a significant spatial

correlation with the balanced and sufficient development among regions, and the balanced and sufficient development of a region is not only related to its own development but also positively affected by the balanced and sufficient development of neighboring regions.

Table 3. Balanced and sufficient development level's global Moran's I value.

Year	Moran's Index	*p* Value
2013	0.403	0.000
2014	0.391	0.000
2015	0.398	0.000
2016	0.403	0.000
2017	0.405	0.000
2018	0.406	0.000
2019	0.399	0.000
2020	0.404	0.000
2021	0.407	0.000

Meanwhile, to better observe the spatial distribution of balanced and sufficient development at the provincial level, ArcGIS 10.2 software based on the division of quartiles is used to map the spatial distribution of the balanced and sufficient development of all provinces from China, taking 2013, 2015, 2017, 2019, 2020, and 2021 as examples (see Figure 1).



(**a**) (**b**)

Figure 1. *Cont.*

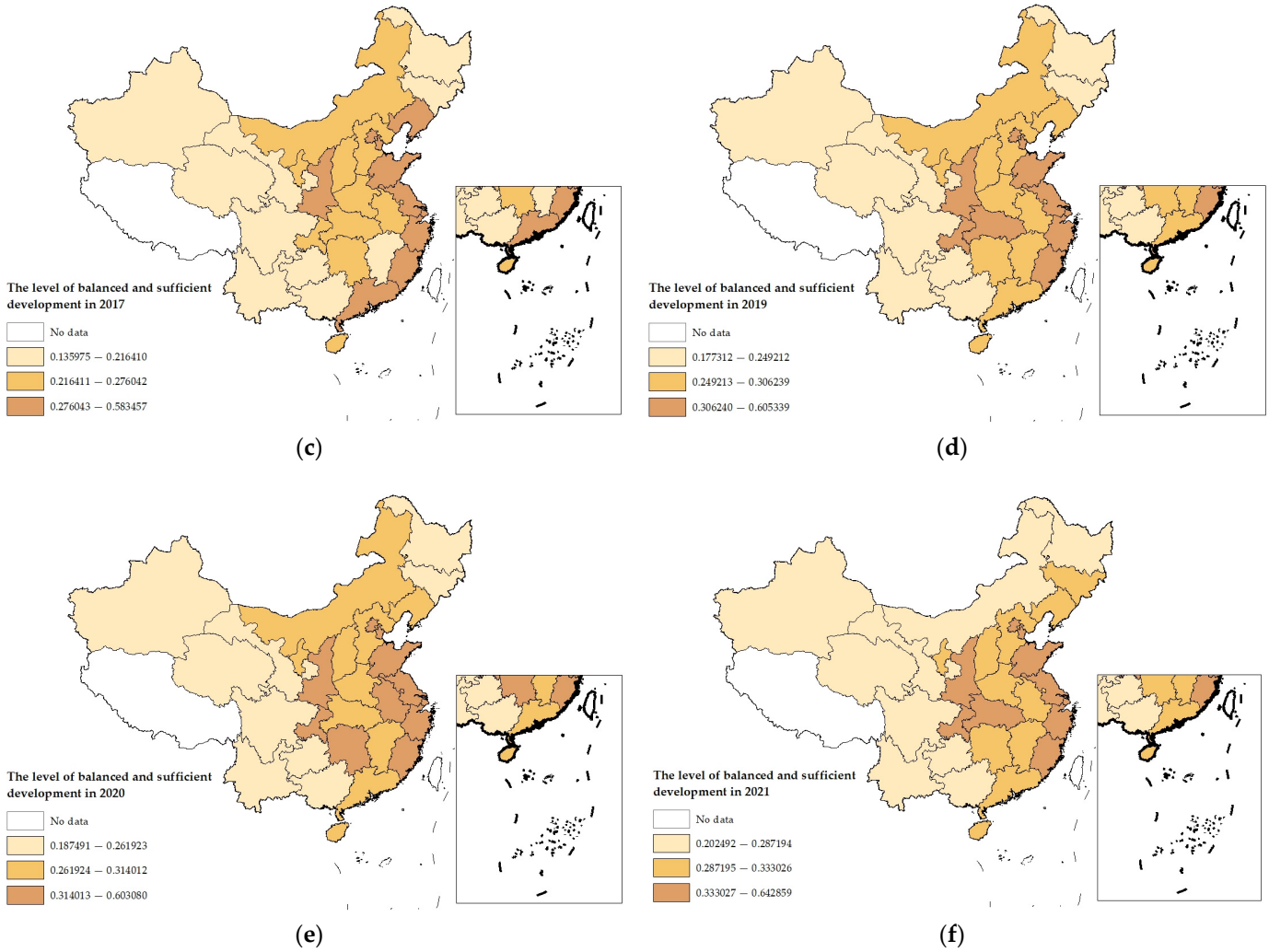


Figure 1. (**a**) The spatial distribution of balanced and sufficient development in 2013; (**b**) the spatial distribution of balanced and sufficient development in 2015; (**c**) the spatial distribution of balanced and sufficient development in 2017; (**d**) the spatial distribution of balanced and sufficient development in 2019; (**e**) the spatial distribution of balanced and sufficient development in 2020; (**f**) the spatial distribution of balanced and sufficient development in 2021.

From Figure 1, it can be seen that there is a spatial dependence effect of the balanced and sufficient development among different regions geographically; the high levels of balanced and sufficient development are concentrated in the eastern coastal areas, while the low levels of balanced and sufficient development are mainly distributed in the central and western regions, showing a "high–high" and "low–low" spatial distribution pattern, namely, regions with a high level of balanced and sufficient development are clustered together, and a low level of balanced and sufficient development appears as area clustering.

4. Modeling Design

4.1. Model Setting

First, we construct the following regression model for the effect of the digital economy on balannced and sufficient development to verify the research assumptions. The form of the model is as follows:

$$BSD_{nt} = \beta Digital_{nt} + \gamma X_{nt} + c_n + \alpha_t + V_{nt} \quad (8)$$

where BSD_{nt} is the level of the balanced and sufficient development of province n in year t, $Digital_{nt}$ is the level of the digital economy of province n in year t, the regression coefficient β reflects the impact of the digital economy on the balanced and sufficient development, X_{nt} represents a series of control variables, c_n is the individual fixed effects, α_t is the time fixed effects, and V_{nt} stands for random disturbance.

Then, to further explore the possible mechanism of the impact of the digital economy on balanced and sufficient development, we test whether the total factor productivity is the intermediary variable, based on Section 2.1. Therefore, on the basis of model (8), we build a regression model of the digital economy affecting the total factor productivity and a regression model of the total factor productivity and the digital economy jointly affecting balanced and sufficient development. Then, we judge whether there is an intermediary effect through the corresponding regression coefficient and significant judgment. The form of the model is as follows:

$$TFP_{nt} = \beta Digital_{nt} + \gamma X_{nt} + c_n + \alpha_t + V_{nt} \tag{9}$$

$$BSD_{nt} = \beta_1 Digital_{nt} + \beta_2 TFP_{nt} + \gamma X_{nt} + c_n + \alpha_t + V_{nt} \tag{10}$$

where TFP_{nt} is the level of total factor productivity of province n in year t, and the meaning of the remaining variables is consistent with model (8). Compared with the output variables, the input variables are easier to control. Therefore, we choose the input-oriented DEA model based on the variable returns to scale the measure of total factor productivity. The form of the input-oriented DEA model is as follows:

$$\min\left\{\theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right)\right\}$$
$$s.t.\begin{cases} \sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta x_{i0} \quad i = 1, 2, \cdots, m \\ \sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{r0} \quad r = 1, 2, \cdots, s \\ \sum_{j=1}^{n} \lambda_j = 1 \\ \lambda_j \geq 0 \qquad j = 1, 2, \cdots, n \end{cases} \tag{11}$$

where θ is the efficiency value; ε is non-Archimedean infinitesimal; s^- and s^+ are the slack variables of input and output variables, respectively; x and y are the input and output variables, respectively; and λ is the weight. According to the existing research by Zhang et al. [34], we select the labor and capital stock as the input variables, where the labor is the total number of employees, and the capital stock is the fixed asset investment after being calculated by the perpetual inventory method. The output indicator is the regional GDP. Among these, the regional GDP and the fixed asset investment are converted to the actual value, with 2013 as the base period, by using the CPI deflator.

4.2. Variable Metrics

4.2.1. Balanced and Sufficient Development

The level of balanced and sufficient development has been measured in Section 3.

4.2.2. Digital Economy

The measurement of the digital economy is mainly about the added value calculation of the digital economy and the compilation of a digital economy index. In terms of the added value calculation of the digital economy, the calculation frameworks proposed by the OECD in 2015 and the US Department of Commerce in 2018 are the most influential. The Australian Bureau of Statistics borrowed the calculation framework of the US Department of Commerce and calculated the added value of the digital economy in 2019. There are also scholars in China who calculated the added value of the digital economy based on these two frameworks (see Xiang and Wu [35] and Xu and Zhang [36]).

However, the added value of the digital economy is always measured at a national level due to data accessibility. Most scholars choose to build an evaluation index system to comprehensively measure the digital economy [13,16,18,19]. Therefore, we use the index of the digital economy to measure the digital economy, based on the research of Liu et al. [37] and Wang et al. [38], and use the panel entropy method to measure the digital economy of 30 provinces in China from 2013 to 2021, as shown in Table 4.

Table 4. The evaluation index system of digital economy.

Level 1 Indicators	Level 2 Indicators	Number	Level 3 Indicators	Attribute
Informatization development	Informatization basics	1	Fiber optic cable density	Positive
		2	Cell phone base station density	Positive
		3	Percentage of information technology practitioners	Positive
	Informatization impact	4	Total telecommunications business	Positive
		5	Software business revenue	Positive
Internet development	Internet basics	6	Internet access port density	Positive
		7	Cell phone penetration rate	Positive
	Internet impact	8	Percentage of Internet broadband users	Positive
		9	Percentage of mobile Internet users	Positive
Digital trading development	Digital trading basics	10	Percentage of corporate owned websites	Positive
		11	Computers per 100 people	Positive
		12	Percentage of enterprises with e-commerce transaction activities	Positive
	Digital trading impact	13	E-commerce sales	Positive
		14	Online retail sales	Positive

4.2.3. Control Variables

The control variables in this paper include government fiscal expenditure, degree of openness, urbanization level, population density, education, employment, and innovation. The government fiscal expenditure is expressed by the proportion of local government fiscal budget expenditures to the local GDP. The degree of openness is expressed by the ratio of total imports and exports to the local GDP. The urbanization level is expressed by the proportion of urban population to the total population. Population density adopts the urban population density for its measurement. Education uses the number of local high school students for its indication. Employment adopts urban registration unemployment rate for its measurement. Innovation is expressed by the volume of local patent applications.

5. Analysis of Empirical Results

5.1. Benchmark Regression

In this paper, a regression with ordinary least squares based on model (8) is used to initially test the impact of the digital economy on balanced and sufficient development, as shown in Table 5.

Table 5. Results of baseline regression.

Variables	(I)	(II)
Digital	0.0433 * (0.0223)	0.115 *** (0.0282)
Control variables	Uncontrolled	Control
Time fixed effects	Control	Control
Provincial fixed effects	Control	Control
N	270	270
R^2	0.9943	0.9954

Notes: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. The value in ( ) is the clustering robust standard error.

In column (I) of Table 5, without adding any control variables, the regression results show that the coefficient of the digital economy on balanced and sufficient development is 0.0433, passing the 10% significance test, which indicates that there is a significant positive relationship between the digital economy and balanced and sufficient development. In column (II) of Table 5, on the basis of column (I), by adding a set of control variables, the

regression results demonstrate that the digital economy still contributes to balanced and sufficient development. Intuitively, for every one percentage point increase in the digital economy, balanced and sufficient development increases by 0.115 percent.

5.2. Endogeneity Test

The results of the above benchmark regressions show that the digital economy can contribute to balanced and sufficient development. However, the above analysis only depends on OLS regressions, and, if there are endogeneity problems, their estimation results are certainly inaccurate. The endogeneity problem in this paper may come from two main sources. On the one hand, there may be omitted variables; although a set of control variables are included in the model, there may still be some unobservable factors. On the other hand, there may be a two-way causality, namely, the level of balanced and sufficient development may affect the level of digital economy. Therefore, we use two different methods of selecting instrumental variables to test the endogenous problems.

The first method of selecting instrumental variables is to set the lag item of the digital economy (lag 1). In addition, we use the 2SLS method to analyze model (8), and the results are shown in column (I) of Table 6.

Table 6. Results of endogeneity test.

Variables	(I)	(II)
Digital	0.0963 *** (0.0306)	0.359 *** (0.0954)
Control variables	Control	Control
Time fixed effects	Control	Control
Provincial fixed effects	Control	Control
LM test	28.001 ***	18.174 ***
Wald F test	565.182 ***	19.095 **
N	240	270
R^2	0.9961	0.8086

Notes: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. The value in ( ) is the clustering robust standard error.

The second method of selecting instrumental variables is that we choose the historical data (local telephone subscriber penetration rate of each province in 1990) as an instrumental variable of the digital economy; this is because the Internet came to the population via telephone line dial-up access technology (see Huang et al. [39]). Therefore, this historical telecommunication foundation may influence the Internet development in each province, according to technology level and usage habits. As a result, regions with a higher historical local telephone user penetration should also be regions with a higher Internet penetration [6,19]. In addition, these historical data are unlikely to have a direct impact on the current level of balanced and sufficient development. Therefore, we construct the interaction term to be between the local telephone subscriber penetration in 1990 and the national Internet investment in the previous year, and we construct the interaction term to be between the local telephone subscriber penetration in 1990 and the amount of national Internet access in the previous year, as the instrumental variables of the digital economy. Among them, the local telephone subscriber penetration rate is expressed by the ratio of the number of local telephone households to the total population, while the national Internet investment amount is generally expressed by the investment in fixed assets for information transmission, computer services, and the software industry, and the price factor is eliminated by the CPI deflator. The data are obtained from the *Compilation of Statistics for the Six Decades of New China* and the *China Statistical Yearbook*. The regression results of the instrumental variables are shown in column (II) of Table 6.

From Table 6, the LM test and Wald F test indicate that the selected instrumental variables are reasonable. The digital economy still has a significant positive impact on balanced and sufficient development, and there is no essential change compared with the results of the benchmark regression, which further confirms the conclusions drawn from the benchmark regression.

5.3. Robustness Test

The above regressions suggest that the digital economy can contribute to a higher level of balanced and sufficient development, but is this finding robust? To address this question, we conduct a robustness test from two aspects.

The first robustness test is that we use additional data [29] to replace the digital economy, as measured in Section 4.2.2. The results are shown in column (I) of Table 7. This shows that although there are differences in the coefficient of the impact of the digital economy on balanced and sufficient development, the impact is still significantly positive, indicating that the conclusion of this paper is robust.

Table 7. Results of robustness test.

Variables	(I)	(II)	
		Eastern Regions	Midwestern Regions
Digital	0.0006218 *** (0.0000)	0.117 *** (0.0451)	0.485 *** (0.1963)
Control variables	Control	Control	Control
Time fixed effects	Control	Control	Control
Provincial fixed effects	Control	Control	Control
N	270	117	153
R^2	0.9212	0.9801	0.9789

Notes: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. The value in ( ) is the clustering robust standard error.

The second robustness test is that we divide the balanced and sufficient development into two categories according to the eastern and midwestern regions. The results are shown in column (II) of Table 7.

This indicates that the digital economy has a significant positive impact on the balanced and sufficient development of different regions, indicating that the conclusion of this paper is robust. In addition, we can further find that the impact varies for the different regions. The digital economy in the midwestern regions has a greater contribution to balanced and sufficient development than that in the eastern regions. We think the cause of this phenomenon is that the level of balanced and sufficient development in the midwestern regions has more room for improvement than that in the eastern regions.

5.4. Mechanism Analysis

From the perspective of total factor productivity, we analyze the possible impact mechanism of the digital economy on balanced and sufficient development based on the theoretical level shown in Section 2. To verify this influence mechanism, we further construct the intermediary effect model for empirical inspection (see model (9) and model (10)). The results are shown in Table 8. In column (1), the coefficient of the digital economy is significantly positive, confirming that the digital economy has a positive impact on balanced and sufficient development. Column (2) verifies whether the digital economy is conducive to improving total factor productivity, and the result shows that it is significantly positive. In addition, the Sobel test and Bootstrap test indicate that there is an intermediary effect in model (10), which is 0.573, indicating that total factor productivity is an important mechanism of the impact of the digital economy on balanced and sufficient development. Among them, the coefficient of the digital economy in columns (I) is the total effect, the coefficient of the digital economy in columns (III) is the direct effect, and the multiplication of the coefficient of the digital economy in columns (II) and the coefficient of the TFP in columns (III) is the indirect effect. Thus, research hypothesis 1 is verified.

Table 8. Results of mechanism analysis.

Variables	(I)	(II)	(III)
	BSD	TFP	BSD
Digital	0.739 *** (0.0440)	1.121 *** (0.0596)	0.316 *** (0.0582)
TFP			0.378 *** (0.0394)
Control variables	Control	Control	Control
Total effect		0.739	
Direct effect		0.316	
Indirect effect		0.423	
Ration of intermediary effects		57.3%	
Sobel test		0.000 ***	
Bootstrap test		0.000 ***	

Notes: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. The value in ( ) is the clustering robust standard error.

6. Further Analysis

6.1. Spatial Effect Analysis

6.1.1. Spatial Econometric Model Setting

From the conclusion of Section 3.2, it is clear that there is a positive spatial correlation, namely, the level of the balanced and sufficient development of one region is positively influenced by that of neighboring regions. Given the fact that the digital economy can achieve a division of labor and cooperation across regions, spatial spillover effects are generated [6,19]. Therefore, we think that the balanced and sufficient development of a region is influenced by the balanced and sufficient development of the surrounding regions as well as the digital economy of the surrounding regions.

To this end, we first set up the spatial panel Durbin model, and then used the Wald test and likelihood-ratio test to judge the fitness of the spatial panel Durbin model. The test results show that the P values are 0.0000 and 0.0001, respectively, indicating that the selection of the spatial panel Durbin model is appropriate. Therefore, we set up the spatial panel Durbin model to explore the spatial effect of the digital economy on balanced and sufficient development. The model is constructed as follows.

$$BSD_{nt} = \lambda W_n BSD_{nt} + \beta Digital_{nt} + \rho W_n Digital_{nt} + \gamma X_{nt} + c_n + \alpha_t l_n + V_{nt} \quad (12)$$

where W_n is the spatial weight matrix; $V_{nt} = (v_{1t}, v_{2t}, \cdots, v_{nt})'$; $v_{it} \sim N(0, \sigma^2)$, which is a random disturbance that satisfies an independent homo-distribution;X_{nt} is a set of control variables; c_n is an individual fixed effect that does not change over time; α_t is the time fixed effect that does not vary with the individual; and l_n is a $n \times 1$ matrix with all elements set as 1. Since the digital economy can break the limitation of geographical distance, the spatial adjacency matrix is no longer appropriate, so the economic spatial weight matrix is chosen instead to better reflect the economic interrelationship between regions, as demonstrated by Lin et al. [40]. $W_n BSD_{nt}$ and $W_n Digital_{nt}$ are the spatial lag terms of balanced and sufficient development and the digital economy, respectively. The meaning of the remaining variables is the same as those of model (8). The common method for estimating the parameters of the general spatial panel Durbin model is the maximum likelihood method. To make the estimation more accurate, the method of Lee and Yu [41] is used to estimate the parameters of model (12).

6.1.2. Spatial Panel Durbin Model Estimation

This section gives the estimation process for the parameters in model (12). For convenience, BSD_{nt} is replaced by $Y_{nt} = (y_{1t}, y_{2t}, \cdots y_{nt})'$, and $Digital_{nt}$ is replaced by D_{nt}, where D_{nt} is a single explanatory variable; then model (12) becomes

$$Y_{nt} = \lambda W_n Y_{nt} + D_{nt}\beta + \rho W_n D_{nt} + X_{nt}\gamma + c_n + \alpha_t l_n + V_{nt} \quad t = 1, 2, \cdots, T \quad (13)$$

In the following, the method of Lee and Yu [41] is used to estimate the parameters of model (13), and the orthogonal transformation method is used to eliminate the time fixed effects in model (13).

Let matrix $J_n = I_n - l_n l_n'/\sqrt{n}$, where I_n is an $n \times n$ identity matrix, and l_n is an $n \times 1$ matrix with all elements of 1. The eigenvalues of J_n are zero and one, and the orthogonal eigenvector matrix is $\left[F_{n,n-1}, l_n/\sqrt{n}\right]$, where $F_{n,n-1}$ is the orthogonal eigenvector matrix with eigenvalues of one, and $l_n/\sqrt{n}$ is the orthogonal eigenvector with an eigenvalue of zero. Since $\left[F_{n,n-1}, l_n/\sqrt{n}\right]$ is an orthogonal matrix,

$$\left[F_{n,n-1}, l_n/\sqrt{n}\right]\left[F_{n,n-1}, l_n/\sqrt{n}\right]' = I_n,\ F_{n,n-1}F_{n,n-1}' = I_n - l_n l_n'/\sqrt{n} = J_n \tag{14}$$

Since W_n is a row normalized $n \times n$ matrix,

$$W_n l_n = l_n, F_{n,n-1}' W_n l_n = F_{n,n-1}' l_n = 0 \tag{15}$$

For any $n \times T$ matrix $Z_{nt} = [Z_{n1}, Z_{n2}, \cdots, Z_{nT}]$, denote $Z_{nt}^* = F_{n,n-1}' Z_{nt}$ and multiply both sides of model (13) by $F_{n,n-1}'$ on the left to obtain

$$Y_{nt}^* = \lambda W_n^* Y_{nt}^* + D_{nt}^* \beta + \rho W_n^* D_{nt}^* + X_{nt}^* \gamma + c_n^* + V_{nt}^* \quad t = 1, 2, \cdots, T \tag{16}$$

where $W_n^* = F_{n,n-1}' W_n F_{n,n-1}$, $c_n^* = F_{n,n-1}' c_n$, and the time fixed effects have been eliminated in model (16) due to $F_{n,n-1}' l_n = 0$.

Denote $Z_{nt}^* = (D_{nt}^*, W_n^* D_{nt}^*, X_{nt}^*)$ and $\delta = (\beta, \rho, \gamma)'$, and model (16) can be simplified as

$$Y_{nt}^* = \lambda W_n^* Y_{nt}^* + Z_{nt}^* \delta + c_n^* + V_{nt}^* \quad t = 1, 2, \cdots, T \tag{17}$$

Through a transposition operation, model (17) becomes

$$(I_{n-1} - \lambda W_n^*) Y_{nt}^* = Z_{nt}^* \delta + c_n^* + V_{nt}^* \quad t = 1, 2, \cdots, T \tag{18}$$

Denote $\theta = \left(\delta, \lambda, \sigma^2\right)'$. According to the random disturbance term $V_{nt}^* \sim N\left(0, \sigma^2 I_{n-1}\right)$, the log-likelihood function of Y_{nt}^* in model (18) is

$$\begin{aligned} \ln L_{n,T}(\theta, c_n^*) = &-\tfrac{(n-1)T}{2} \ln 2\pi - \tfrac{(n-1)T}{2} \ln \sigma^2 \\ &+ T \ln|I_{n-1} - \lambda W_n^*| - \tfrac{1}{2\sigma^2} \sum_{t=1}^{T} V_{nt}^{*\prime}(\theta) V_{nt}^*(\theta) \end{aligned} \tag{19}$$

According to the calculation $|I_{n-1} - \lambda W_n^*| = \frac{1}{1-\lambda}|I_n - \lambda W_n|$, Equation (19) becomes

$$\begin{aligned} \ln L_{n,T}(\theta, c_n^*) = &-\tfrac{(n-1)T}{2} \ln 2\pi - \tfrac{(n-1)T}{2} \ln \sigma^2 - T \ln(1-\lambda) \\ &+ T \ln|I_n - \lambda W_n| - \tfrac{1}{2\sigma^2} \sum_{t=1}^{T} V_{nt}^{*\prime}(\theta) V_{nt}^*(\theta) \end{aligned} \tag{20}$$

where $V_{nt}^*(\theta) = (I_{n-1} - \lambda W_n^*) Y_{nt}^* - Z_{nt}^* \delta - c_n^*$, simplifying for $V_{nt}^*(\theta)$ gives

$$\begin{aligned} V_{nt}^*(\theta) &= F_{n,n-1}'(I_n - \lambda W_n) F_{n,n-1} F_{n,n-1}' Y_{nt} - F_{n,n-1}' Z_{nt} \delta - F_{n,n-1}' c_n \\ &= F_{n,n-1}'(I_n - \lambda W_n)\left(I_n - \tfrac{1}{n} l_n l_n'\right) Y_{nt} - F_{n,n-1}' Z_{nt} \delta - F_{n,n-1}' c_n \\ &= F_{n,n-1}'[(I_n - \lambda W_n) Y_{nt} - Z_{nt} \delta - c_n] \end{aligned} \tag{21}$$

Then, it follows that

$$\begin{aligned} V_{nt}^{*\prime}(\theta) V_{nt}^*(\theta) &= [(I_n - \lambda W_n) Y_{nt} - Z_{nt} \delta - c_n]' F_{n,n-1} F_{n,n-1}' [(I_n - \lambda W_n) Y_{nt} - Z_{nt} \delta - c_n] \\ &= [(I_n - \lambda W_n) Y_{nt} - Z_{nt} \delta - c_n]' J_n [(I_n - \lambda W_n) Y_{nt} - Z_{nt} \delta - c_n] \\ &= V_{nt}'(\theta) J_n V_{nt}(\theta) \end{aligned} \tag{22}$$

Substituting Equation (22) into Equation (20) gives

$$\begin{aligned}\ln L_{n,T}(\theta, c_n) = &-\tfrac{(n-1)T}{2}\ln 2\pi - \tfrac{(n-1)T}{2}\ln\sigma^2 - T\ln(1-\lambda)\\ &+ T\ln|I_n - \lambda W_n| - \tfrac{1}{2\sigma^2}\sum_{t=1}^{T} V_{nt}'(\theta) J_n V_{nt}(\theta)\end{aligned} \tag{23}$$

where $V_{nt}(\theta) = (I_n - \lambda W_n)Y_{nt} - Z_{nt}\delta - c_n$, let the log-likelihood function (23) be a partial derivative with respect to c_n, and let it be zero.

$$\frac{\partial \ln L_{n,T}(\theta, c_n)}{\partial c_n} = \frac{1}{\sigma^2}\sum_{t=1}^{T}((I_n - \lambda W_n)Y_{nt} - Z_{nt}\delta - c_n)J_n = 0 \tag{24}$$

Solving model (24), we can obtain $c_n = \frac{1}{T}\sum_{t=1}^{T}[(I_n - \lambda W_n)Y_{nt} - Z_{nt}\delta]$, and, substituting c_n into Equation (23), we can obtain

$$\begin{aligned}\ln L_{n,T}(\theta) = &-\tfrac{(n-1)T}{2}\ln 2\pi - \tfrac{(n-1)T}{2}\ln\sigma^2 - T\ln(1-\lambda)\\ &+ T\ln|I_n - \lambda W_n| - \tfrac{1}{2\sigma^2}\sum_{t=1}^{T} \tilde{V}_{nt}'(\theta) J_n \tilde{V}_{nt}(\theta)\end{aligned} \tag{25}$$

where $\tilde{V}_{nt}(\theta) = (I_n - \lambda W_n)\tilde{Y}_{nt} - \tilde{Z}_{nt}\delta, \tilde{Y}_{nt} = Y_{nt} - \frac{1}{T}\sum_{t=1}^{T} Y_{nt}$, and $\tilde{Z}_{nt} = Z_{nt} - \frac{1}{T}\sum_{t=1}^{T} Z_{nt}$.

Finally, let the log-likelihood function (25) be biased with respect to the parameters $\theta = \left(\delta, \lambda, \sigma^2\right)'$, so the first-order partial derivative condition is as follows:

$$\begin{aligned}\frac{\partial \ln L_{n,T}(\theta)}{\partial \theta} &= \begin{pmatrix} \frac{\partial \ln L_{n,T}(\theta)}{\partial \delta} \\ \frac{\partial \ln L_{n,T}(\theta)}{\partial \lambda} \\ \frac{\partial \ln L_{n,T}(\theta)}{\partial \sigma^2} \end{pmatrix} = \begin{pmatrix} \frac{1}{\sigma^2}\sum_{t=1}^{T}\left(J_n\tilde{Z}_{nt}\right)'\left[(I_n - \lambda W_n)\tilde{Y}_{nt} - \tilde{Z}_{nt}\delta\right] \\ \frac{1}{\sigma^2}\sum_{t=1}^{T}\left[\left(J_n W_n\tilde{Y}_{nt}\right)'\left[(I_n - \lambda W_n)\tilde{Y}_{nt} - \tilde{Z}_{nt}\delta\right]\right] + \frac{T}{1-\lambda} - T\frac{W_n}{I_n - \lambda W_n} \\ \frac{1}{2\sigma^4}\sum_{t=1}^{T}\left[(I_n - \lambda W_n)\tilde{Y}_{nt} - \tilde{Z}_{nt}\delta\right]' J_n\left[(I_n - \lambda W_n)\tilde{Y}_{nt} - \tilde{Z}_{nt}\delta\right] - \frac{(n-1)T}{2\sigma^2} \end{pmatrix} \\ &= \begin{pmatrix} \frac{1}{\sigma^2}\sum_{t=1}^{T}\left(J_n\tilde{Z}_{nt}\right)'\tilde{V}_{nt}(\theta) \\ \frac{1}{\sigma^2}\sum_{t=1}^{T}\left[\left(J_n W_n\tilde{Y}_{nt}\right)'\tilde{V}_{nt}(\theta)\right] + \frac{T}{1-\lambda} - T\frac{W_n}{I_n - \lambda W_n} \\ \frac{1}{2\sigma^4}\sum_{t=1}^{T}\left[\tilde{V}_{nt}'(\theta) J_n\tilde{V}_{nt}(\theta) - (n-1)\sigma^2\right] \end{pmatrix}\end{aligned} \tag{26}$$

By making the first-order partial derivatives equal to zero, a consistent estimate for the parameters $\theta = \left(\delta, \lambda, \sigma^2\right)'$ can be obtained, and, finally, an effective estimate of the parameters of the spatial panel Durbin model is obtained.

6.1.3. Decomposition of Spatial Effects

Although more and more attempts of estimation methods have been completed for the parameters of the spatial panel Durbin model, the estimated coefficients of the spatial panel Durbin model can only confirm the positive or negative effects of the digital economy on balanced and sufficient development, which fails to reflect the extent of its impact. Therefore, the impact of the digital economy on balanced and sufficient development needs to be further decomposed into a direct effect and an indirect effect. The direct effect reflects the influence of the digital economy of the region on the balanced and sufficient development of the region, while the indirect effect reflects the influence of the digital economy from the neighboring regions on the balanced and sufficient development of the region. After shifting the term of Equation (12), we obtain

$$BSD_{nt} = (1 - \lambda W_n)^{-1}(\beta Digital_{nt} + \rho W_n Digital_{nt} + \gamma X_{nt}) + (1 - \lambda W_n)^{-1}(c_n + \alpha_t l_n + V_{nt}) \quad (27)$$

Then, at time t, the impact of the digital economy on balanced and sufficient development can be reflected by the matrix of partial derivatives from region 1 to n:

$$\begin{bmatrix} \frac{\partial BSD_1}{\partial Digital_1} & \cdots & \frac{\partial BSD_1}{\partial Digital_n} \\ \vdots & \ddots & \vdots \\ \frac{\partial BSD_n}{\partial Digital_1} & \cdots & \frac{\partial BSD_n}{\partial Digital_n} \end{bmatrix} = (1 - \lambda W_n)^{-1}(\beta I_n + \rho W_n) \quad (28)$$

where the partial derivative indicates the effect of the digital economy in a particular space on the balanced and sufficient development of itself (direct effect) or of other spatial units (indirect effect). The mean value of the diagonal elements is defined as the direct effect, while the mean value of the nondiagonal elements is defined as the indirect effect, and the decomposition of the spatial effects is shown in Table 9. The results of spatial effect decomposition show that the direct effect, indirect effect, and total effect of the digital economy on balanced and sufficient development are significantly positive, indicating that not only the digital economy of the region can improve the balanced and sufficient development of the region but also the digital economy of the surrounding areas can improve the balanced and sufficient development level of the region. Thus, research hypothesis 2 is verified.

Table 9. Decomposition of spatial effects.

Variables	Direct Effect	Indirect Effect	Total Effect
Digital	0.106 *** (0.0353)	0.238 ** (0.0697)	0.344 *** (0.0754)
Control variables	Control	Control	Control
Time fixed effects	Control	Control	Control
Provincial fixed effects	Control	Control	Control
N	270	270	270
R^2	0.8313	0. 8313	0. 8313

Notes: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. The value in ( ) is the clustering robust standard error.

6.2. Analysis of Spatial Spillover Effects

The results of the above spatial effect analysis indicate that there is a spatial spillover effect of the digital economy, but the details of it are still to be analyzed. In this section, the spatial spillover effect of the digital economy will be further analyzed by the spatial Markov chain method; the economic spatial weight matrix is still selected as the spatial weight matrix, and the quantile method is used to classify the digital economy level and spatial lag term into three level types: symbol I indicates high level, symbol II indicates medium level, and symbol III indicates low level. The results of the spatial Markov probability transfer matrix calculation are shown in Table 10.

First, it is easy to see that there is a spatial agglomeration effect in the digital economy, with low-level digital economy regions tending to be adjacent to low-level regions, and high-level digital economy regions tending to be adjacent to high-level regions. This is because areas surrounded by a high level of digital economy (spatial lag type I) mostly belong to areas with a high level of digital economy, while areas surrounded by a medium level of digital economy (spatial lag type II) mostly belong to areas with a medium level of digital economy; by that analogy, areas surrounded by a low level of digital economy (spatial lag type III) generally belong to areas with a low level of digital economy. Second, the level of the digital economy has the feature of stability to maintain the original state, with the tendency of a low level of the digital economy flowing to a high level of the digital economy. Since, in the spatial Markov probability transfer matrix, the main diagonal transfer probability is larger than the nondiagonal transfer probability, the value on the left is significantly larger than the value on the right. Third, the spatial spillover effect of

the digital economy is related to the spatial context, indicating that being closer to an area with a high digital economy causes a more obvious spillover effect by the digital economy. From the analysis, for III type of the spatial lag, the probability of an upward shift by the low and medium digital economy areas is 0.1875 and 0.1739, respectively. As the level of the digital economy in adjacent areas increases, the lag type changes from III to II, and the probability of an upward shift by the low and medium digital economy areas is 0.4 and 0.1923, respectively. With an increase in transfer probability, the digital economy spillover effect becomes more obvious.

Table 10. Spatial Markov probability transfer matrix for the digital economy.

Type of Spatial Lag	Type	Frequency 240	I	II	III
I	I	6	1	0	0
	II	6	0.5	0.5	0
	III	0	0	0	0
II	I	50	1	0	0
	II	52	0.1923	0.8077	0
	III	25	0	0.4	0.6
III	I	14	1	0	0
	II	23	0.1739	0.8261	0
	III	64	0	0.1875	0.8125

7. Conclusions

Based on the panel fixed effect model, mediation effect model, and spatial econometric model, this paper focuses on exploring the impact of the digital economy on balanced and sufficient development. The main conclusions are as follows: First, we construct an index system to measure the level of balanced and sufficient development at the provincial level in China from 2013 to 2021, finding that the level of balanced and sufficient development in the eastern areas is higher than that of the midwestern regions, but the growth rate of the midwestern regions is faster than that of the eastern regions. Second, the digital economy can promote the improvement of balanced and sufficient development, and this conclusion is still valid after the endogeneity test and robustness test; we also find that the digital economy has a better effect in the midwestern regions. Third, the total factor productivity is an important mechanism of the impact of the digital economy on balanced and sufficient development. Fourth, the digital economy has a spatial spillover effect, and this spillover effect is related to the spatial background. Being closer to a high-level area of the digital economy means that the spillover effect of the digital economy is more obvious.

In addition to the empirical evidence that the digital economy can promote balanced and sufficient development, the analysis of this paper also provides some policy implications. First, based on the reality that the digital economy can promote the improvement of balanced and sufficient development, the government can actively expand investment in the information industry and speed up the construction of new digital infrastructure, such as 5G base stations, artificial intelligence, and industrial Internet, to promote the development of digital industries and consolidate the integration of the digital economy in industry, so that the digital economy can further become an effective way to promote balanced and sufficient development. Second, considering that the digital economy has a better effect in the midwestern regions, the government can implement a dynamic and differentiated strategy for the digital economy to match its local resource advantages. It is appropriate to form the digital economy's own reasonable development system, which can further alleviate the situation of the unbalanced and insufficient development between regions. Third, based on the fact that the digital economy has a spatial spillover effect, the government can build a regional coordinated development network by using digital technology to promote digital industrialization and industrial digitization and realize the cross-regional division of labor and cooperation, thus improving the situation of the unbalanced and insufficient development within and between regions.

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