

# Study on the Efficiency of Digital Inclusive Finance Enabling Regional Development in Shaanxi Province

Xiyu Yang\*

Department of Business Administration, Xi'an International Studies University, Xi'an, 710128, China

\*Corresponding author: YANGxiyu1186@163.com

**Abstract:** Based on data from 10 prefecture-level cities in Shaanxi Province from 2016 to 2020, this paper used the DEA-BCC model to conduct an empirical study on the effectiveness of digital inclusive finance in promoting regional development in Shaanxi Province from a static perspective. The results show that within Shaanxi Province, the comprehensive efficiency of Xi'an City and Yulin City is in the optimal state, while the average value of the comprehensive efficiency of Weinan City, Hanzhong City, Ankang City, and Shangluo City is lower, and the main influencing factor is scale efficiency. Therefore, there is a need to increase the scale of digital inclusive finance coverage breadth, usage depth, and digitization level in prefecture-level cities with low comprehensive efficiency, and to make relevant recommendations in five aspects: increasing digital infrastructure construction, enhancing financial education and training, optimizing financial product design, promoting regional coordinated development, and encouraging innovation and piloting.

**Keywords:** Digital Inclusive Finance; Shaanxi Province; Regional Development; DEA

## 1. Introduction

With the rapid development of technology, the financial industry is undergoing a major transformation. As a new model for financial services, digital inclusive finance is bringing new vitality to traditional financial services through the application of advanced technological tools such as big data, cloud computing, and artificial intelligence. In the context of China's modern economic development, digital inclusive finance has become an important tool to boost economic growth, optimize resource allocation, and achieve social justice.

Rich in natural resources and humanistic landscapes, Shaanxi Province is a significant economic hub in western China. However, there is still a degree of uneven and inadequate development in the financial services sector, particularly in rural areas. The enabling function of digital inclusive finance is especially crucial to better support Shaanxi Province's regional development. It is possible to significantly lower the barrier to financial services, mitigate the lack of financial resources, and revitalize Shaanxi Province's regional development by promoting and implementing digital inclusive finance.

But how to gauge the effectiveness of digital inclusive financing in promoting regional development in Shaanxi Province has emerged as a crucial concern. This study develops a system to assess the effectiveness of the growth of digital inclusive finance in Shaanxi Province by taking into account three factors: the extent of coverage, the level of usage, and the degree of digitalization of digital inclusive financial services. It seeks to offer helpful references and recommendations for the development of digital inclusive finance in Shaanxi Province by empirically assessing the growth of this sector in each prefecture-level city between 2016 and 2020.

## 2. Literature Review

As an emerging financial service model, digital inclusive finance, through the use of digital technology, realizes the innovation and optimization of traditional financial services, and provides a new impetus for regional development in Shaanxi Province. Currently, the research on regional development efficiency in Shaanxi Province is mainly divided into two parts: the evaluation method of regional development efficiency and the construction of regional development efficiency evaluation index system.

### **2.1 Regional development efficiency evaluation method**

1) Fuzzy evaluation method. Zhang Xiaoli and Wang Hongsheng (2023) take 33 prefecture-level cities along the Yellow River Basin as an example, and use the fuzzy set qualitative comparative analysis method to explore the optimal enhancement path for the development of digital inclusive finance in the Yellow River Basin Economic Zone in order to improve the balance of regional development<sup>[1]</sup>.

2) Entropy value method. Ni Yeqing (2023) used the entropy value method to construct comprehensive indicators for measuring the level of regional coordinated development, analyzed the impact mechanism of digital inclusive finance on the overall coordinated development of the region as well as the four dimensions of the coordinated development of the region, including economic growth, consumption level, governmental public services, and ecology, and ultimately the study showed that digital inclusive finance has a significant role in the coordinated development of the regional economy<sup>[2]</sup>. Guo Ping et al. (2022) used the entropy method to measure and evaluate the financial efficiency level of 91 counties (cities) in Shanxi Province, and the results showed that the overall financial efficiency of the counties in Shanxi Province in 2019 was low, and showed more obvious geographical differences<sup>[3]</sup>.

3) Data envelopment analysis (DEA) method. This method is a commonly used method to study the issue of regional development efficiency of digital inclusive financial empowerment. Li Jigang and Hao Fulei (2022) used a three-stage Malmquist index model to analyze the efficiency of the promotion of common wealth by digital inclusive finance in 31 provinces in China from 2011 to 2020, and the results show that the comprehensive efficiency of digital inclusive finance in most provinces has not yet reached the optimal state, in which the impact of China's digital inclusive finance total factor efficiency is slower than technological progress. The main factor is slower technological progress<sup>[4]</sup>. Huang Xueping (2023) used the DEA-BCC model to measure and analyze the efficiency of digital inclusive financial services in the governance of relative poverty in western rural areas from a static perspective, used the DEA-Malmquist index model to analyze the changes in efficiency from a dynamic perspective, and finally used the DEA-Tobit model to study the efficiency of the DEA-BCC model. Finally, the DEA-Tobit model is used to study the influencing factors of efficiency<sup>[5]</sup>.

### **2.2 Construction of regional development efficiency evaluation index system**

The regional development efficiency evaluation index system of Shaanxi Province is mainly composed of two parts: regional development inputs and development outputs. Regional development input is that digital inclusive finance promotes local development by facilitating the development of enterprises; regional development output is the role of digital inclusive finance in the development of Shaanxi Province's prefectural-level cities. Currently, the Peking University Digital Inclusion Financial Center and Ant Technology Group jointly produce the Peking University Digital Inclusion Financial Index (2011-2020), which is highly authoritative in China. Although there have been quite a lot of domestic studies on the efficiency of regional development empowered by digital inclusive finance, most of them take China as a whole as the object of study, and there are relatively few studies on a particular province<sup>[6]</sup>.

Therefore, this paper measures the regional development efficiency of digital inclusive financial empowerment in Shaanxi Province based on the DEA model, aiming at exploring new paths to promote the high-quality development of Shaanxi Province region.

## **3. Research methodology**

### **3.1 Data Envelopment Analysis (DEA)**

The data envelopment analysis (DEA) model, first proposed by Charnes, Cooper, and Rhodes in 1978, is a nonparametric statistical method for evaluating the performance of decision-making units (DMUs), used primarily to study production with multiple inputs and multiple outputs. In the traditional DEA model, it can be divided into CCR model and BCC model. The CCR model is an output-oriented model with convex quantitative constraints, used primarily to study the level of inputs and outputs under a variable rate of return on scale (VRS) to measure technical efficiency. The BCC model can be decomposed from the composite technical efficiency (TE) to the pure technical efficiency (PTE) and the Scale Efficiency (SE) for analysis. This study focuses on changes in the integration efficiency of digital financial inclusion rather than output maximization. Therefore, assuming that scale is variable, i.e., efficiency depends on scale, a cost-sensitive DEA-BCC model was selected that is more compatible with

the objectives of this study. The formula for the DEA model is as follows:

$$\left\{ \begin{array}{l} \min \theta \\ \text{s.t. } \sum_{j=1}^n \lambda_j x_j \leq \theta x_0 \\ \sum_{j=1}^n \lambda_j y_j \geq y_0 \\ \sum_{j=1}^n \lambda_j = 1 \\ \theta \text{ unrestricted, } y_i \geq 0, j = 1, 2, \dots, n \end{array} \right. \quad (1)$$

Where  $x_j$  denotes the input vector of the  $j$ th sample,  $y_j$  denotes the output vector of the  $j$ th sample, and  $\lambda_j$  denotes the weight of the  $j$ th sample. The model produces three main output efficiency values, i.e., combined efficiency (TE), pure technical efficiency (PTE) and scale efficiency (SE), which have the following product relationship:

$$\theta_{TE} = \theta_{PTE} \times \theta_{SE} \quad (2)$$

The closer the values of these three efficiency values are to 1, the higher the level of efficiency is. When these three efficiency values reach 1, it means that the inputs and outputs have reached an optimal state. Among them, when  $\theta_{TE} = 1$ , it indicates that the decision-making unit is in the optimal state under the stable technology level; when  $\theta_{PTE} = 1$ , it manifests that the decision-making unit resources realize rational allocation and effective technical efficiency, if  $\theta_{PTE}$  is smaller, it indicates that the decision-making unit needs to enhance the technical input more and more to improve the resource allocation condition; when  $\theta_{SE} = 1$ , it manifests that the decision-making unit is in the scale effective state at the present time. Specifically, comprehensive efficiency (TE) is the ratio of actual output to theoretical output under fixed input conditions, which measures the efficiency of resource allocation and utilization under certain economic information inputs. Pure technical efficiency (PTE), on the other hand, is a measure of output efficiency under the existing level of management and institutional model. Scale efficiency (SE), on the other hand, is the efficiency of production affected by changes in the scale of input resources, and it reflects the gap between the actual scale of production and the optimal scale of production.

### 3.2 Data sources

The article studies the digital financial inclusion data of 10 prefecture-level cities in Shaanxi Province, with a time span of 2016-2020, and the input and output variables are derived from the report "Peking University's Digital Financial Inclusion Index (2011-2020)", and the statistical yearbooks and statistical bulletins of each prefecture-level city in Shaanxi Province, respectively.

### 3.3 Selection of Indicators

Table 1: Input-output indicator system of the efficiency of regional development in Shaanxi empowered by digital inclusive finance

Level 1 indicators	Secondary indicators
Input indicators	Coverage breadth
	Usage depth
	Digitization level
Output indicators	GDP per capita
	Per capita disposable income

The input index is chosen based on the scope of digital financial inclusion, the extent of digital financial inclusion usage, and the digitalization of financial inclusion. Output indicators are evaluated in relation to GDP per capita and disposable income per capita. The significance of the input and output indicators lies in the impact of the three dimensions of digital financial inclusion on the regional development of the 10 prefecture-level cities in Shaanxi Province. A higher level of efficiency indicates that the unit of digital inclusive finance input leads to better regional development output.

The input-output indicator system is presented in Table 1.

## 4. Empirical findings

According to the DEA model, digital financial inclusion is measured in 10 prefecture-level cities in

Shaanxi Province with the help of DEAP2.1 software, and the results are shown in Table 2.

Table 2: Digital financial inclusion efficiency of 10 prefecture-level cities in Shaanxi Province from 2016 to 2020

Range of efficiency values	Mean value of combined efficiency	Mean value of pure technical efficiency	Mean value of scale efficiency
Xi'an	1.0000	1.0000	1.0000
Tongchuan	0.9178	1.0000	0.9178
Baoji	0.8704	0.9716	0.8960
Xianyang	0.8404	0.9664	0.8696
Weinan	0.7828	0.9986	0.7840
Yan'an	0.9258	1.0000	0.9258
Hanzhong	0.7646	0.9768	0.7826
Yulin	1.0000	1.0000	1.0000
Ankang	0.7044	0.9856	0.7150
Shangluo	0.6938	1.0000	0.6938

From the above table, it can be seen that among the 10 prefecture-level cities in Shaanxi Province, Xi'an and Yulin City have higher comprehensive efficiency and Shangluo City has lower comprehensive efficiency; in pure technical efficiency, Xi'an, Tongchuan, Yan'an, Yulin and Shangluo City have higher pure technical efficiency and Xianyang City has lower pure technical efficiency; and in scale efficiency, Xi'an and Yulin City have higher scale efficiency and Shangluo City has lower scale efficiency. It can be concluded that digital financial inclusion efficiency in comprehensive efficiency and scale efficiency, Xi'an city and Yulin city have significant results in implementation relative to other prefecture-level cities, so it can bring better development to the local finance of Xi'an city and Yulin city. In pure technical efficiency, Xi'an, Tongchuan, Yan'an, Yulin and Shangluo cities have higher pure technical efficiency, so it can be concluded that the pure technical efficiency of digital inclusive financial efficiency is better implemented in Xi'an, Tongchuan, Yan'an, Yulin and Shangluo; for Xianyang city, which has a lower value of the result, the pure technical efficiency can be improved by improving its technological innovation capacity.

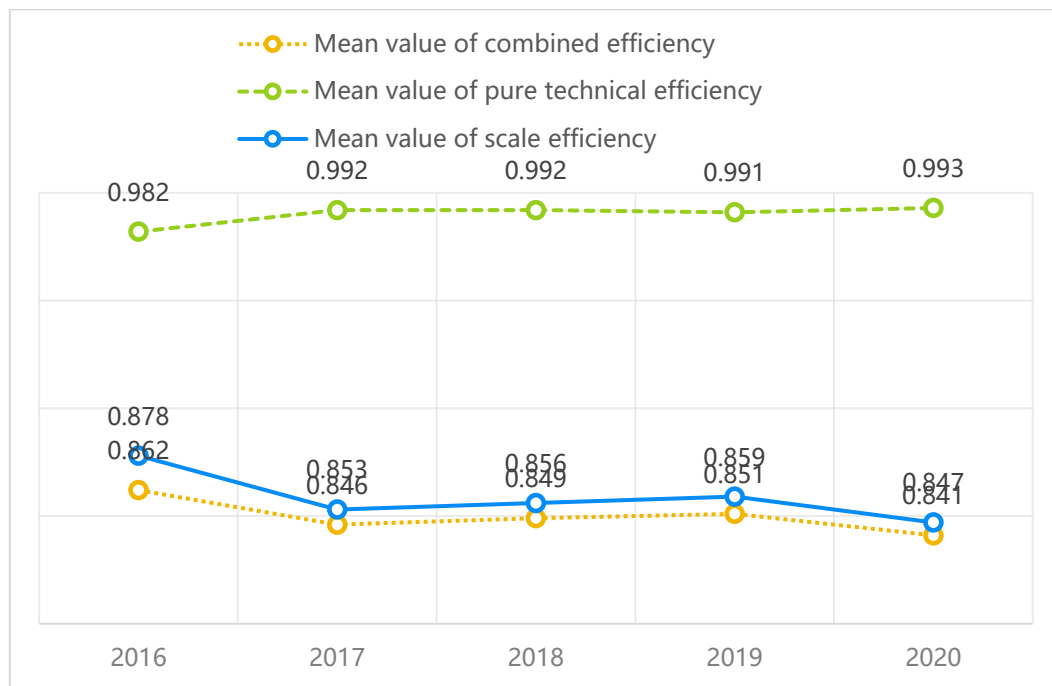


Figure 1: Trend in the efficiency of digital inclusive finance-enabled regional development in Shaanxi Province, 2016-2020

From the above figure 1, it can be seen that the comprehensive efficiency and scale efficiency curves converge and are consistent, and have shown a downward trend in the past five years, indicating that the decline in comprehensive efficiency is mainly caused by scale efficiency, while pure technical efficiency shows an upward trend and the average is greater than the comprehensive efficiency and scale efficiency, which can be concluded that it is necessary to increase the scale of the input indicators to improve the scale efficiency, thus improving the comprehensive efficiency. Specifically, it is necessary to expand the scale of digital financial inclusion in terms of breadth of coverage, depth of use and degree of digitization.

## 5. Conclusions and Recommendations

### 5.1 Research Conclusion

Through empirical analysis, it has been determined that Xi'an City and Yulin City exhibit optimal comprehensive efficiency compared to other prefecture-level cities in Shaanxi Province, with an average comprehensive efficiency value of 1. Conversely, Weinan City, Hanzhong City, Ankang City, and Shangluo City demonstrate lower average comprehensive efficiency values, all below 0.8. The primary factor influencing comprehensive efficiency is scale efficiency, necessitating an increase in the breadth of coverage, depth of use, and digitization of digital financial inclusion. When considering the temporal aspect, the trend of comprehensive efficiency in Shaanxi Province indicates a decline during the period of 2016-2020, highlighting the need to expand the scale of digital inclusive finance to enhance the comprehensive efficiency of the prefecture-level cities in Shaanxi Province.

### 5.2 Relevant Suggestions

#### (1) Increase the construction of digital infrastructure

The government should increase funding for the development of digital infrastructure in prefecture-level cities with low comprehensive efficiency, such as Weinan City, Hanzhong City, Ankang City, and Shangluo City. This will increase Internet coverage and mobile payment penetration, laying the groundwork for the growth of digital inclusive finance.

#### (2) Enhancing financial education and training

Enhance financial knowledge and digital skills training for farmers and micro and small business owners to improve their financial literacy and ability to use digital financial tools, so that they can better utilize digital inclusive financial services.

#### (3) Optimize financial product design

Financial institutions should design financial products and services that are more in line with local needs and easy to use, based on the actual situation of prefecture-level cities such as Weinan, Hanzhong, Ankang and Shangluo, so as to improve the attractiveness and utilization rate of financial services.

#### (4) Promote coordinated regional development

By enhancing the radiation-driven role of areas with high comprehensive efficiency, such as Xi'an and Yulin, the government should promote inter-regional resource sharing and complementary advantages, and drive the development of neighboring prefecture-level cities.

#### (5) Encouraging Innovation and Piloting

Select conditional regions to carry out pilots of digital inclusive finance empowering regional development, and gradually promote them after summarizing the experience, so as to form a replicable and sustainable development model.

## References

- [1] Zhang Xiaoli, Wang Hongsheng. *Research on the development path of digital inclusive finance in the Yellow River Basin Economic Zone based on fuzzy set analysis*[J]. *Regional Financial Research*, 2023(04):18-23.
- [2] Ni Yeqing. *Research on the impact of digital inclusive finance on regional coordinated development* [D]. *Shandong Institute of Commerce and Industry*, 2023.
- [3] Guo Ping, Liu Jialin, Zheng Li. *Measurement and Evaluation of Financial Efficiency in County Areas of Shanxi Province Based on Entropy Value Method* [J]. *North China Finance*, 2022(07):78-84.
- [4] LI Jigang, HAO Fulei. *Measuring the common wealth efficiency of digital inclusive financial services* [J]. *Statistics and Decision Making*, 2022, 38(17):140-144.
- [5] Huang Xueping. *Research on the efficiency of digital inclusive financial services in western rural areas under the perspective of relative poverty governance* [D]. *Southwest University of Science and Technology*, 2023.
- [6] Gao Wei, Gao Jiajing. *Research on the efficiency measurement and influencing factors of digital inclusive financial services for the real economy*[J]. *Statistics and Decision Making*, 2023,39(15):125-130.