Research on the Development Efficiency of Digital Technology Enabled Commerce and Trade Circulation in the Yangtze River Economic Belt Based on Three Stage DEA Malmquist Index Decomposition

Yan Li, Sai Zhang*(✉)

School of Economics, Harbin University of Commerce, Harbin 150028, China

Email: 1353066511@qq.com

Abstract. In the era of digital economy, ICT has made unprecedented development in the storage and processing capacity of data and information, and promoted the construction of modern commercial circulation system. Based on the Three-stage DEA and Malmquist index model, using the panel data of 11 provinces and cities in the Yangtze River economic belt from 2015 to 2020, this paper makes a static and dynamic analysis of the efficiency of digital technology enabled commerce and trade circulation in the Yangtze River economic belt. The results show that digital technology significantly drives the development of Commerce and trade circulation industry, and the overall change of total factor productivity shows a fluctuating upward trend, which is mainly driven by technological progress, and there are certain differences between the upstream, middle and downstream, and the difference is widening. In this regard, three suggestions are put forward, including accelerating the construction of public big data platform, strengthening the innovative leading role of digital technology, and implementing the digital development strategy of differentiated business economy.

Keywords: Three stage DEA model; Malmquist index; Digital technique; Trade circulation efficiency

1 Introduction

In recent years, digital technology has become the most potential and dynamic emerging field in China. Its rapid development has injected new vitality and provided a new direction for the commercial circulation industry. The advantages of the Yangtze River Economic Belt in terms of resources, transport and other aspects have contributed to its development as one of the most dynamic regions in China, and General Secretary Xi proposed at the symposium that the Yangtze River Economic Belt should be given a new mission in terms of coordinated regional development and innovation-driven development, so as to make it the main force leading the high-quality development of the economy. It is of great significance to study whether the

Y. Jiao et al. (eds.), *Proceedings of the 3rd International Conference on Internet Finance and Digital Economy (ICIFDE 2023)*, Atlantis Highlights in Economics, Business and Management 1,
https://doi.org/10.2991/978-94-6463-270-5_53

digital technology can enable the trade circulation industry to drive the rapid development of the Yangtze River economic belt, and how the development differences of trade circulation industry in different regions are.

2 Review of relevant literature

There are few relevant studies, which can be roughly divided into two categories: one is the impact of digital technology on business circulation, Li Dengjin[1], Chang Shangxin[2], Chen Xiang[3], Chen Xiaoli[4]found that the digital technology has a positive impact on the development of urban trade and commerce circulation industry, Zhou Lin et al[5] pointed out the main mode of digital development of trade and commerce circulation through the case study, and then put forward in the digital transformation of the pains faced by the difficulties, which puts forward the recommendations. Another category is the study of the coordinated development of digital technology and trade circulation, Qin Yang[6], Ye Yueqing[7] and Li Yezheng[8] studied the regional data and found that the overall synergy increased year by year and the local differences were significant. Liu Ning[9] 's study proved that the ecosystem of agricultural product circulation platforms belongs to the typical mutually beneficial symbiosis mode between the ecosystem and the development of e-commerce.

It is generally believed that it is necessary for the commercial circulation industry to transform to digital, but there are relatively few articles on the development efficiency of the industry from the perspective of digital technology empowerment. In view of this, this paper takes 11 provinces and cities covered by the Yangtze River economic belt as an example, selects the Three-stage DEA and Malmquist model, calculates and compares the development efficiency of the commercial circulation industry, and hopes to provide reference for the government on how to coordinate the coordinated development of the two and narrow the gap in the small region.

3 Modelling and selection of indicators

3.1 Three-stage DEA model

$$\min \theta - \varepsilon(\hat{e}^T S^- + e^T S^+)$$

$$s.t. \begin{cases} \sum_{j=1}^{n} X_j \lambda_j + S^- = \theta X_0 \\ \sum_{j=1}^{n} Y_j \lambda_j - S^+ = Y_0 \\ \lambda_j \geq 0, S^-, S^+ \geq 0 \end{cases} \tag{1}$$

According to Fried [10]et al. to construct the following SFA-like regression function:

$$S_{ni} = f(Z_i; \beta_n) + v_{ni} + \mu_{ni} \tag{2}$$

$$E[v_{\mathrm{ni}} | v_{\mathrm{ni}} + \mu_{\mathrm{ni}}] = \mathrm{s_{ni}}\text{-}\mathrm{f}(z_i; \beta_n)\text{-}\mathrm{E}[u_{\mathrm{ni}} | v_{\mathrm{ni}} + \mu_{\mathrm{ni}}] \tag{3}$$

$$X_{ni}^{A} = X_{ni} + [max(f(Z_i; \hat{\beta}_n)) - f(Z_i; \hat{\beta}_n)] + [max(v_{ni}) - v_{ni}] \tag{4}$$

$$E(\mu|\varepsilon) = \sigma_* \left[\frac{\phi(\lambda\frac{\varepsilon}{\sigma})}{\Phi(\frac{\lambda\varepsilon}{\sigma})} + \frac{\lambda\varepsilon}{\sigma} \right] \tag{5}$$

3.2 Malmquist exponential modelling

The Malmquist index can be decomposed:

$$M_t(x_{t+1}, y_{t+1}, x_t, y_t) = \frac{D_{t+1}(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)} \times \left[\frac{D_t(x_{t+1}, y_{t+1})}{D_{t+1}(x_{t+1}, y_{t+1})} \times \frac{D_t(x_t, y_t)}{D_{t+1}(x_t, y_t)} \right]^{\frac{1}{2}} \tag{6}$$

3.3 Selection of indicators and data sources

Table 1. Input output index

Primary indicators	Secondary indicators	Tertiary indicators
Input variables	Digital infrastructure construction	Long distance optical cable line length
	Development scale of digital technology	Internet penetration, software industry investment, telecom business volume
	Application degree of digital terminal	Number of subscribers and switch capacity of mobile phones at the end of the year
Output variables	Economic operation status	Total sales of social retail goods

The input-output indicators are shown in Table 1. The data are from 11 provinces and cities in the China Statistical Yearbook and the provincial and Municipal Statistical Yearbook from 2015 to 2020, which are calculated and decomposed using formulas (1) to (6), deap2.1 and front4.1 software.

4 Empirical analysis

4.1 Three-stage DEA static analysis of the development efficiency of the trade and distribution industry

It can be seen from Table 2 that after the adjustment, there is still a big gap between the development synergy effect of the upstream, middle and downstream digital technology and the commercial circulation industry. Jiangsu, Zhejiang and Shanghai have always been at the forefront of efficiency, and are more advanced in the management and technology of the commercial circulation industry. Hunan, Yunnan and Guizhou are far lower than the average level of the Yangtze River economic belt, and the gap is obvious.

Table 2. Comparison of DEA results of the first and third phases

DMU	Combined efficiency			Pure technical efficiency			Scale efficiency		
	TE1	TE3	orienta-tions	PTE 1	PTE 3	orienta-tions	SE1	SE3	orienta-tions
Shanghai	1.000	1.000	-	1.000	1.000	-	1.000	1.000	-
Jiangsu	1.000	1.000	-	1.000	1.000	-	1.000	1.000	-
Zhejiang	1.000	1.000	-	1.000	1.000	-	1.000	1.000	-
Anhui	0.978	0.972	↓	1.000	1.000	-	0.978	0.972	↓
Down-stream average	0.995	0.993	↓	1.000	1.000	-	0.995	0.993	↓
Jiangxi	0.707	0.837	↑	0.808	0.916	↑	0.875	0.914	↑
Hubei	0.902	1.000	↑	1.000	1.000	-	0.902	1.000	↑
Hunan	0.715	0.852	↑	0.816	0.928	↑	0.876	0.918	↑
Midstream average	0.775	0.896	↑	0.875	0.948	↑	0.884	0.944	↑
Chongqing	1.000	0.985	↓	1.000	1.000	-	1.000	0.985	↓
Sichuan	0.816	0.924	↑	0.893	1.000	↑	0.914	0.924	↑
Yunnan	0.671	0.818	↑	0.814	0.851	↑	0.824	0.961	↑
Guizhou	0.672	0.840	↑	0.827	0.878	↑	0.812	0.957	↑
upstream average	0.790	0.909	↑	0.884	0.950	↑	0.888	0.957	↑
on average	0.853	0.933	↑	0.919	0.966	↑	0.922	0.965	↑

Regionally, the average efficiency ranking is still lower reaches>upper reaches>middle reaches. The average efficiency of trade circulation in the upper and middle reaches of the Yangtze River has improved, but the gap with the lower reaches is still obvious, and the external environment needs to be reasonably improved.

4.2 Dynamic analysis of the Malmquist index

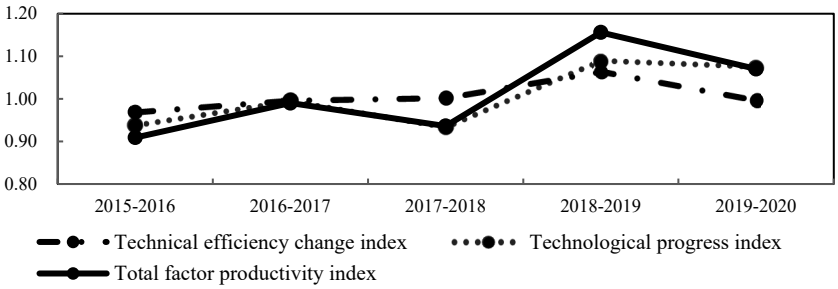

Fig. 1. Plot of changes in Malmquist index of efficiency of trade flows

Total factor productivity increased at an average annual rate of 1.2%. In Figure 1, from 2015 to 2018, the index was less than 1, in a backward state, and began to improve in 2018.

5 Summary and recommendations

The study found that the development efficiency of commercial circulation industry was significantly affected by digital technology. The regional development is uneven, and the efficiency ranking is: downstream>upstream>midstream, the difference is large and expanding. The change trend shows that the change of total factor productivity shows a fluctuating growth trend of first rising and then falling, and then rising and then falling, which is mainly driven by technological progress.

First of all, we should speed up the construction of public big data platform, provide data support and services for the upstream and downstream industries of the trade circulation industry, break down the data barriers, connect the upstream and downstream of the supply chain, and realize the real sense of data circulation.

Secondly, we should strengthen the innovative leading role of the digital economy and improve the technical level of the commercial circulation industry. Commercial circulation enterprises should actively embrace digital technologies such as blockchain, and scientifically and reasonably implement the digital transformation of production, sales, storage and other links.

In addition, we should implement the digital development strategy of differentiated commercial economy. The downstream should promote the large-scale development of the commercial circulation industry on the basis of the original digitalization, and the resources can be appropriately inclined to the middle and upper reaches.

Funded project

Heilongjiang Province Philosophy and Social Sciences Research Planning Project: Research on the Green Development Path of Heilongjiang Province's Industrial Structure under Carbon Constraints (22JYE463)

Reference

1. Li Dengjin. The impact of digital economy development on the circulation efficiency of agricultural products under the new development pattern[J]. Research on Business Economy,2023(09):93-96.
2. Chang Shangxin. Digital Economy Enables Digital Transformation and Innovation of Business Circulation Enterprises[J]. Business and Economic Research,2022(18):124-127.
3. Chen Xiang. Research on the impact of digital economy on urban commerce and distribution industry[J]. Research on Business Economy,2022(06):32-35.
4. Chen Xiaoli. Impact of digital transformation of supply chain on China's commerce and circulation industry--taking the provinces along the Yangtze River Economic Belt as an example[J]. Research on Business Economy,2023(12):119-122.
5. ZHOU Lin, WANG Xiaoyi. Research on the Transformation and Development of Commerce and Circulation Industry in the Era of Digital Economy[J]. Research on Business Economy,2022(07):12-15.
6. Qin Yang. Discussion on the consumption upgrading effect of the integrated development of Internet and distribution industry under digital economy[J]. Business and Economic Research,2021(12):22-25.
7. Ye Yueqing, Wang Dong. The mechanism of efficiency improvement of regional commerce and circulation industry development empowered by digital economy--Based on the experience of Zhejiang Province[J]. Research on Business Economy,2021(14):18-22.
8. Li Yezheng. Coordinated Development of Digital Economy and Business Circulation Industry under Regional Synergy Mechanism- An Empirical Analysis Based on Southwest Region[J]. Research on Business Economy,2023(05):176-180.
9. LIU Ning, ZHANG Ying, ZHANG Xu. Research on the synergistic evolution path of China's agricultural product circulation platform ecosystem[J].Business and Economic Research,2022(17):146-149.
10. Fried H O, Lovell C A K, Schmidt S S, et al. Accounting for Environmental Effects and Statistical Noise in Data Envelopment Analysis [J].Productivity Analysis, 2002,17(1):157-174.