Empirical Research and Analysis on the Development of Digital Economy and Communication Industry - Taking the Chengdu Chongqing Economic Circle as an Example

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Abstract: As a key link between production and consumption, the level of development of the circulation industry will greatly affect prosperity of a region. In the context of the digital economy, improving the efficiency and competitiveness of the circulation industry is of great significance for building a new development pattern of "dual circulation". This article uses panel data from 15 cities in the Chengdu Chongqing Economic Circle from 2014 to 2021 to quantitatively evaluate the development level of digital economy and circulation industry in each city using the entropy method, and conducts empirical research on the degree of correlation between the two. The empirical results show that the degree of digital economy development in Chengdu-Chongqing twin city economic circle will have a significant impact on the circulation industry of the cities in the circle. So, it is a wise choice to accelerate development of circulation industry and promote urban prosperity by strengthening construction of digital economy infrastructure, increasing the construction of circulation infrastructure around Chengdu economic circle and coordinating the development.

Keywords: Digital economy; Circulation industry; Chengdu Chongqing Dual City Economic Circle; Fixed effects

1 Introduction

The circulation industry serves as the intermediary connecting the manufacturing end and the consumption end, plays an vital role in regulating supply and demand balance and meeting the needs of production and consumption. Circulation industry has achieved certain development, especially after the 8th meeting of the Central Committee of Finance and Economics proposed to elevate the construction of a modern circulation system to an important national strategic task. The circulation industry has become an important focus and enterprises to promote the factors distribution and labor division between regions. Information technologies have broken through traditional economic development models, spurred the emergence of new formats, empowered industries with new vitality, brought new opportunities for economic development, and also provided opportunities for upgrading and transforming traditional circulation industries. At first glance, empowering the traditional circulation industry with the digital economy can optimize the circulation process, reduce costs, and improve circulation efficiency by increasing information input. However, the influence degree and mechanism of

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the level of digital economy on the circulation industry still need further exploration and analysis.

In the 2019 Key Tasks for New Urbanization Construction, it is explicitly stated that Chengdu Chongqing urban agglomeration is of giant significance in coordinating the prosperity of the east and west, narrowing the development disparity between the East and the West, resolving social contradictions accumulated in China's development. However, whether in terms of geographical location, economic strength, or development time, there is still a big gap between Chengdu-Chongqing city group and the other three city groups. Promoting the economic construction of Chengdu-Chongqing twin City economic Circle is advantageous to accelerating pattern of dual-core drive in Chengdu-Chongqing region, narrowing the development gap with developed urban agglomerations, and creating major opportunities for achieving common prosperity. In previous studies on the circulation industry about Chengdu Chongqing Economic Circle, most of the literature was limited to the circulation industry itself or its impact on regional economy. There are few studies exploring the impact of circulation industry from the perspective of digital economy. Digital economy is an irreplaceable and momentous role in promoting the transition of traditional circulation industry. In view of this, this article selects data and indicators related to digital economy and circulation industry in the Chengdu Chongqing Economic Circle from 2014 to 2021 for empirical analysis, providing theoretical suggestions for development of circulation industry

2 Literature Review

2.1 Research on Digital Economy

Twenty-seven years ago, American scholar Don Topscott first proposed the "digital economy"[1]. Initially, they believed that the digital economy includes e-commerce infrastructure, e-commerce, and e-commerce[2]. Subsequently, the viewpoint of the digital economy gradually broke through the perspective of e-commerce, defining it as an economic form built on digital and communication infrastructure[3]. Later on, the digital economy was believed to include the entire process of producing and selling goods or services using digitization[4]. Although there is no unified conceptual cognition, most studies believe that digital economy is newly-developing economic shape, which will bring new changes to the next economic development and lifestyle.

2.1.1 Digital Economy Measurement

There are a variety of measurement methods for digital economy indicators. Some scholars use the "Internet plus" urban digital economy development index, digital economy enterprise data, industrial added value and other single indicators prepared by Tencent Research Institute to measure. There are also scholars who measure the development of the digital economy through multiple indicators, primarily constructing a multi indicator system from multiple dimensions such as the China Digital Inclusive Finance Index, digital industrialization, digital infrastructure, and industrial digital development, using comprehensive measurement indicators such as entropy method, principal component analysis, and aggregation method. comprehensively used the improved entropy method and linear combination method to calculate the development level of digital economy in 255 cities from 2015 to 2020 from four

aspects: digital popularization, digital innovation, digital industry, and digital finance[5]. Using principal component analysis to measure the level of digital economy development from five indicators: internet penetration rate, internet related practitioners, internet related output, mobile phone penetration rate, and China Digital Inclusive Finance Index.[6]

2.1.2 The economic effects of the digital economy

The research on the economic impact about the digital economy is mainly based on perspectives such as technological innovation, organizational operational efficiency, factor allocation efficiency, spatial spillover, and green and low-carbon innovation. For example, digital economy can provoke human capital investment and promote industrial structure upgrading, thereby improving the total factor productivity of the region[7]. Digital transformation can increase the total factor productivity by improving innovation capabilities and reducing costs through mechanisms[8]. Digital economy, as a new element, can accelerate economic dynamic cycles, knowledge spillovers and other effects to improve the efficiency of factor allocation[9].

2.2 Research on the Development of Circulation Industry in Chengdu Chongqing Urban Agglomeration

The evolution standard of circulation industry in Chengdu-Chongqing economic circle is higher and higher year by year, but overall lags behind other economic circles[10]. The development of circulation industry about Chengdu Chongqing group agglomeration is relatively lagging due to severe industrial homogeneity among various cities within the agglomeration, with most cities having no large-scale comparative advantage industries and lower innovation strength in circulation compared to the eastern region[11]. Circulation industry in the Chengdu Chongqing urban has shown obvious dual city characteristics in the development process, and the Matthew effect is obvious, which is not profitable about the overall development of circulation industry in the Chengdu Chongqing urban agglomeration[12]. Weak industrial foundation, lagging development of digital economy and technology finance, severe loss of high-tech talents, and relatively low per capita disposable income and the gap with urban economic circles such as the Yangtze River Delta and Beijing Tianjin Wing still shows a certain degree of widening trend[13].

3 Mechanism analysis of digital economy to enhance the development level of circulation industry

The key to studying the relationship between the two is to obtain deepgoing understanding of how the digital economy has affected circulation industry. Firstly, digital economy can optimize industrial chain of circulation industry and improve circulation efficiency. The digital economy and circulation industry have given birth to large-scale e-commerce platforms and new circulation models. The emergence of digital platforms has weakened the role of intermediaries in the circulation process, making the relationship between consumers and upstream manufacturing industry closer and tending to gather together in space. Secondly, the digital economy can promote consumption expansion and upgrading, providing development opportunities for the circulation industry. Integrating digital information into circulation

enterprises helps them accurately monitor the sales and circulation of goods. Enterprises that produce goods adjust their products and services based on consumer feedback. Circulation enterprises continuously optimize the circulation process to further meet the derivative needs of consumers. With the continuous replacement of products and services, the commodity market continues to expand, providing greater opportunities for the enhancement of circulation industry and also enhancing opportunities for the continuous updating and upgrading of circulation enterprises. Finally, digital finance in the digital economy can broaden and enrich financing channels for circulating enterprises. In the past, due to the impact of information asymmetry, circulation enterprises faced difficulties in financing, long financing processes, and high financing costs. Speedy evolution of the digital economy allows financial institutions to comprehensively evaluate credit capacity of circulation enterprises through large numbers, improving market information asymmetry. As a result, financing channels for circulation enterprises have increased, while financing costs have decreased. Hence, the following assumptions can be made:

Hypothesis 1:The level of commercial circulation in Chengdu-Chongqing economic circle can be improved by digital economy.

4 Research design

4.1 Indicator selection and data sources

4.1.1 Development level of digital economy

Based on the White Paper on China's Digital Economy Index, the indicators for measuring the digital economy are constructed using the entropy method, starting from the three dimensions of information technology development level, namely digital industrialization, industrial digitization, and digital environment. The weights of the indicators are calculated to evaluate the level of digital economy development in the Chengdu Chongqing Economic Circle. Specific indicators and weight details are shown in Table 1

Table 1 Evaluation index system of digital economy.

Level I Indicators	Secondary Indicators	Weight
Digital industrialization	Telecom business scale/100 million yuan	0.148
	Postal business scale/100 million yuan	0.182
	Number of employees in the digital industry/10000 people	0.078
Industrial digitization	Express delivery volume/100 million pieces	0.210
	Proportion of e-commerce enterprises/%	0.043
	Digital Inclusive Finance Index	0.070
Digital environment	Talent Support/Institute	0.051
	Financial support/%	0.156
	Mobile Internet penetration rate/%	0.029
	Internet penetration rate/%	0.033

4.1.2 Development level of commercial circulation industry

The evaluation indicators for the development level of general commercial circulation industry

are selected to measure the added value or proportion of the tertiary industry in four industries.In order to objectively and comprehensively consider the indicators of the commercial circulation industry, as well as the availability of data, Based on the research of Yang Renfa (2023) [14], this paper constructs indicators from three aspects: circulation scale, circulation potential and circulation benefit, and then calculates the evaluation results of the development level of commercial and trade circulation in Chengdu-Chongqing twin City economic Circle through entropy method..Specific indicators and weight details are shown in Table 2

Table 2 Evaluation index system of commercial and trade circulation industry.

Level I Indicators	Secondary Indicators	Weight
Circulation scale	Industry added value/100 million yuan	0.371
	Total retail sales/100 million yuan	0.296
	Logistics turnover/100 million tons per kilometer	0.222
Circulation potential	Per capita consumption expenditure/(yuan/person)	0.048
Circulation efficiency	Labor productivity/%	0.063

4.1.3 Control variable

In terms of control variables, selecting urbanization level, government intervention, fixed assets investment, economic development level, foreign direct investment level and economic openness as control variables, and urbanization level, social consumption level and fixed assets investment as replacement control variables to test the robustness of the regression model.The specific indicators and weights of control variables are detailed in Table 3

Table 3 Variable selection and its meaning.

Variable	Symbol	Define
Urbanization level	Urrb	Urban population/total population
Government intervention level	Gov	Government fiscal expenditure/Gross Domestic Product
Fixed assets investment	Inve	Fixed asset expenditure/Gross Domestic Product
Foreign direct investment	FDI	Total amount of foreign direct investment in each city
Economic Openness	Open	Import and export volume in each province/GDP*100
Social consumption level	Cons	Total social retail sales in each province/GDP*100
Level of economic development	Deve	Regional Gross Domestic Product/Regional Population

Urbanization level (URB), expressed as the ratio of urban permanent population to total permanent population. The level of urbanization can affect the industrial structure and thus have an impact on the circulation industry. The degree of government intervention (go) can affect the business environment of a region, thereby affecting the development of a certain industry. The degree of government intervention is represented by the proportion of government fiscal expenditure to GDP. Fixed assets investment (invest) refers to the level of government investment in infrastructure construction. The level of infrastructure will greatly affect the development of the circulation industry, which is expressed by the ratio of fixed asset expenditure to GDP. In addition, the level of foreign direct investment, regional economic development, social consumption, and regional openness will all have an impact on the development of the commercial circulation industry.

4.2 Data sources

Data were given by the Sichuan Statistical Yearbook, Chongqing Statistical Yearbook from 2014 to 2021 and China Economic Database, .

5 Empirical analysis

5.1 Model Settings

In order to explore the relationship between the digital economy and the commercial circulation industry, the following econometric model was constructed:

$$Circu_{it} = \alpha_0 + \beta \cdot Del_{it} + \eta \cdot X_{it} + \mu_i + \mu_t + \varepsilon_{it} \quad (1)$$

Among them, $Circu_{it}$ represents the development level of the commercial circulation industry in the I city district in the th T year, and Del_{it} represents the development level of the digital economy in the I city district in the T year; α_0 represents the intercept term,β and η represents the estimated coefficient; X_{it} Represents control variables;μ_i Represents the fixed effect of the I city; μ_t represents Annual fixed effect representing the T year;Last symbol represents random error term;

5.2 Descriptive statistical analysis of variables

Table 4 presents the descriptive analysis results of each variable from 2014 to 2021. It indicates that there is a significant difference in the development level of commercial circulation industry between regions in different years, and the control variables between regions in different years also differ significantly.

Table 4 Descriptive Statistical Analysis of Variables.

Variable	Mean	Std. Dev.	Min	Max	Number of Samples
Del	0.140	0.186	0.009	0.799	120
Circu	0.145	0.196	0.012	0.997	120
Gov	21.525	6.258	13.723	67.522	120
Invest	82.957	20.639	6.258	13.723	120
Urrb	3.924	0.164	3.578	4.380	120

Deve	10.708	0.319	10.044	11.451	120
FDI	7.849	23.094	0.03	131.7	120
Cons	0.411	0.100	0.075	0.557	120
Open	0.076	0.098	0.003	0.413	120

5.3 regression results

This section of this article is based on the results of the Hausman test, where the P-value is less than 0.05. Therefore, a fixed effects model is chosen for parameter estimation to empirically test the impact of the digital economy on the high-quality development of the commercial circulation industry. To avoid the problem of multicollinearity, a stepwise regression method is used to test the robustness of the model.

The empirical results are shown in Table 5. Model (1) in Table 5 only includes explanatory variables for regression The correlation between the two is strong.Models two to four in the table show four control variables: non control variables and gradually adding foreign direct investment, government participation, consumption level, and openness to the outside world. The research results indicate that the development level of the digital economy has passed the 1% significance test, indicating that the digital economy development of the Chengdu Chongqing Shuangcheng Economic Circle can have a very significant impact on the development of the commercial circulation industry. As the control variables were added one by one, the goodness of fit of the model remained at a high level, indicating a strong explanatory power of the model.

Table 5 Regression Results.

Variable	(1)	(2)	(3)	(4)	(5)
Del	0.898*** (0.060)	0.888*** (0.052)	0.893*** (0.052)	0.894*** (0.054)	0.906*** (0.502)
FDI		0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
Gov			0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Cons				0.044 (0.083)	0.063 (0.082)
Open					0.144*** (0.079)
Individual fixed effects	Yes	Yes	Yes	Yes	Yes
Annual fixed effects	Yes	Yes	Yes	Yes	Yes
Intercept	0.217*** (0.033)	0.257*** (0.029)	0.263*** (0.030)	0.259 (0.031)	0.298 (0.037)
Adj R^2	0.9830	0.9875	0.9828	0.9873	0.9876
Sample size	120	120	120	120	120

Note: *** is significant at 1% levels.

5.4 Robustness Test

Replace the core explanatory variable measurement method. The core explanatory variable of this article is a comprehensive indicator determined based on the entropy method. In order to reduce the correlation between various indicators in the explanatory variable, principal component analysis is now used to calculate the comprehensive indicators of the core explanatory variable for robustness testing. The test results can be seen in Table 6 Model (8).

Excluding the sample data in 2020, regression analysis was conducted to exclude the impact of the COVID-19 on the development level of the digital economy and the development level of the commercial circulation industry. The regression results are shown in Table 6. Model (9)

Replace the control variables, and conduct regression analysis with four control variables: urbanization rate, economic development level, fixed assets investment instead of foreign direct investment, government fiscal expenditure, social consumption level and openness. See Table 6 model (10) for detailed results.

The model was re estimated using random effects, and the results are shown in Table 6 Model (11).

From models (8) to (11), it can be seen that the coefficient of the core explanatory variable digital economy Del has consistently passed the 1% level test, indicating that the positive impact of the digital economy on the development of the commercial circulation industry obtained from the regression results is robust.

Table 6 Robustness Test.

	Robust Test			
	Principal Components	Excluding the 2020 sample	Replace control variable indicators	Using Fe estimation
	(8)	(9)	(10)	(11)
	Circu	Circu	Circu	Circu
Del	0.083*** (0.007)	0.933*** (0.054)	0.898*** (0.065)	0.982*** (0.038)
Urrb			0.011 (0.057)	
Deve			-0.053 (0.071)	
Invest			0.001*** (0.000)	
LM				
Sargan-Hansen				
Wald F				
Individual fixed effects	Control	Control	Control	Control
Time fixed effect	Control	Control	Control	Control
Observations	120	105	120	120

Note: *** is significant at 1% levels.

5.5 Further Discussion

According to section 5.3, during the sample period, the digital economy has a significant positive direct impact on the commercial and trade flow industry in the Chengdu Chongqing

dual city economic circle; That is to say, within the Chengdu Chongqing dual city economic circle, the digital economy has increasingly turn into an momentous power in driving the development of commercial circulation industry.

6 Conclusions and Recommendations

This article starts from three dimensions: digital industrialization, industrial digitization, and digital environment, and uses entropy method to comprehensively measure the development indicators of digital economy and the development environment of commercial circulation industry in the Sichuan Chongqing Dual City Economic Circle. The empirical results show that the development of digital economy in the Chengdu Chongqing Economic Circle can significantly promote the development of commercial circulation industry. Therefore, this article proposes the following suggestions:

Firstly, actively facilitate the development and elevate the level of digital economy development. Digital economy , can integrate with traditional industries, improve output efficiency, and implement transformation or upgrading. However, currently, China's digital economy has just started,There is a big development gap with countries that started earlier and still a lot of room for development. Strengthen the construction of new digital economic infrastructure, big data,and cloud computing in Chengdu Chongqing Economic Circle, increase research investment in new technologies related to the digital economy and the shortcomings of the existing digital economy, encourage innovative development of digital technology, provide technical support, and enhance the development of the digital economy in the Chengdu Chongqing Economic Circle, Furthermore, it promotes the development of the commercial circulation industry. In addition, the development of the digital economy can also promote the digital transformation of the commercial circulation industry by expanding digital channels for commercial circulation, reducing technological barriers and transformation costs, and promoting high-quality and efficient development of the circulation industry.

Secondly,Strengthen the construction of infrastructure in the circulation industry. The affect of the digital economy on a region's commercial circulation industry may not only lie in the development level of the digital economy itself, but also in the more complete infrastructure construction related to the commercial circulation industry, making the promotion effect of the digital economy on the commercial circulation industry more obvious. Therefore, improving the infrastructure of the Chengdu Chongqing dual city economic circle can play a greater role in promoting the development of the commercial circulation industry through the digital economy.

Thirdly, coordinate and promote common development. The Chengdu Chongqing dual city economic circle, as a systematic project, needs to be planned comprehensively and play a dual city linkage role. In addition to expanding openness to each other and promoting industrial integration, the Chengdu Chongqing twin cities should also strengthen exchanges and cooperation with other cities, achieve resource sharing and complementary advantages, enhance market vitality

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